Flagstaff Watershed Protection Project

Silviculture Report

Prepared by:
Andy Stevenson
District Silviculturist

for:
Flagstaff Ranger District
Coconino National Forest

07/02/2014

Table of Contents

Introduction 1
Overview of Issues Addressed 3
Methodology, Assumptions and Limitations 5
Affected Environment 10
Existing Conditions 10
Desired Conditions 39
Need for Change 46
Environmental Consequences 55
Ponderosa Pine – Dry Lake Hills 55
Alternative 1 – No Action 56
Alternatives 2, 3, & 4 56
Ponderosa Pine – Mormon Mountain 68
Alternative 1 – No Action 68
Alternatives 2, 3, & 4 68
Mixed Conifer- Dry Lake Hills 76
Alternative 1 – No Action 76
Alternatives 2, 3, & 4 77
Mixed Conifer – Mormon Mountain 91
Alternative 1 – No Action 91
Alternatives 2 & 3 91
Alternative 4 93
Monitoring Recommendations 130
References (Literature Cited) 131

List of Tables

Table 1: Proposed Action FVS Treatment Modeling Assumptions by Treatment Type in the Dry Lake Hills 8
Table 2: Proposed Action FVS Treatment Modeling Assumptions by Treatment Type in Mormon Mountain 9
Table 3: Past and ongoing treatment history of the Dry Lake Hills 14
Table 4: Past and ongoing treatment history of the Mormon Mountain portion of FWPP 15
Table 5: Analysis Area Cover Type Acres 16
Table 6: Description of Vegetation Structural Stages (VSS) 25
Table 7: Existing Dominant VSS assessed at the stand level within Dry Lake Hills Ponderosa Pine outside of MSO recovery habitat. 25
Table 8: Relationships of Forest Density to Forest Stand Development and Tree Characteristics 27
Table 9: Stocking Guides to Meet Tree Group Canopy Cover Requirements within Goshawk Habitat Areas Outside of PFAs (LOPFA) 29
Table 10: Stocking Guides to Meet Tree Group Canopy Cover Requirements within Goshawk PFAs 29
Table 11: Mexican Spotted Owl Habitat Stratification within the Analysis Area (Acres within each project site) under the 2012 MSO recovery plan. 30
Table 12: Northern Goshawk Habitat Stratification within the Analysis Area (Acres by project site) 30
Table 13: Existing Spotted Owl Habitat Forest Structure and Habitat Components 32
Table 14: Existing Goshawk Nest/PFA Habitat Forest Structure and Habitat Components 33
Table 15: Existing Goshawk LOPFA Habitat Forest Structure and Habitat Components 33

Table 16: Existing Forest Structure – Goshawk LOPFA Stands Percent of Area by Vegetative Structural Stages. 34
Table 17: Existing Forest Structure – Goshawk PFA/Nest Stands Percent of Area by Vegetative Structural Stages. 34
Table 18: Acres and percent of existing old growth by cover type and site potential located within FWPP. Cover Type and need for old growth are shown separately for the Dry Lake Hills and Mormon Mountain 34
Table 19: Existing Ponderosa Pine Beetle Hazard Rating (Percent of stands in each Project Area) 37
Table 20: EC - Dwarf Mistletoe Infection Level of ponderosa pine and mixed conifer within the Flagstaff Watershed Protection Area, Coconino National Forest. 38
Table 21: Desired Vegetative Structural Stage (VSS) distribution for the northern goshawk, according to the Forest Plan, for the Dry Lake Hills area 47
Table 22: Proposed Treatment Descriptions, Objectives and Acres 48
Table 23: Proposed Treatments and their focus (restoration versus fire risk reduction) 54
Table 24: Small scale analysis of current conditions using data analyzed at the plot level and broken out into nest, PFA, and LOPFA areas. Average values calculated at the point level using individual stand exam plot data. Dry Lake Hills, FWPP. 63
Table 25: Mid-scale analysis of current stand condition using data analyzed at the stand level and broken out into nest, PFA and LOPFA areas. Average values calculated by stand broken out by LOPFA, PFA, Nest areas, MSO PAC treatments and MSO PAC Nest Burn Only treatments. Dry Lake Hills, FWPP 64
Table 26: Large scale analysis of current conditions across all goshawk areas treated within the Dry Lake Hills Area. Stand values averaged across all ponderosa pine stands within the northern goshawk habitat. Dry Lake Hills, FWPP 64
Table 27: Stand values of post vegetation treatment conditions (2013) for LOPFA, PFA, and Nest areas. Dry Lake Hills, FWPP 65
Table 28: Average stand values of the no action and action alternatives projected 20 years out (2033). Dry Lake Hills, FWPP 66
Table 29: Average stand values of the no action and action alternatives projected 40 years out (2053). Dry Lake Hills, FWPP 67
Table 30: Stand values of current conditions and post treatment conditions for Ponderosa Pine Fuels Reduction treatments. Mormon Mountain, FWPP 73
Table 31: Average stand values of no action and proposed alternatives projected 20 years out for ponderosa pine stands. Mormon Mountain, FWPP. 74
Table 32: Average stand values of no action and proposed alternatives projected 40 years out for ponderosa pine stands. Mormon Mountain, Flagstaff Watershed Protection Project, Coconino National Forest. 75
Table 33: Stand values of current conditions and post treatment conditions for Mixed Conifer Fuels Reduction treatments. Dry Lake Hills, FWPP 85
Table 34: Average stand values of no action and proposed alternatives projected 20 years for Mixed Conifer Fuels Reduction treatments. Dry Lake Hills, Flagstaff Watershed Protection Project, Coconino National Forest 87
Table 35: Average stand values of no action and proposed alternatives projected 40 years for Mixed Conifer Fuels Reduction treatments. Dry Lake Hills, Flagstaff Watershed Protection Project, Coconino National Forest 89
Table 36: Stand values of current conditions and post treatment conditions for Mixed Conifer Fuels Reduction treatments. Mormon Mountain, FWPP 93
Table 37: Average stand values of no action and proposed alternatives projected 20 years for Mixed Conifer Fuels Reduction treatments. Mormon Mountain FWPP 93

Table 38: Average stand values of no action and proposed alternatives projected 40 years for Mixed Conifer Fuels Reduction treatments. Mormon Mountain, FWPP 94
Table 39: Stand values of current conditions and post treatment conditions for Wet Mixed Conifer Fuels Reduction treatments. Mormon Mountain, FWPP..... 96
Table 40: Average stand values of no action and proposed alternatives projected 20 years for Wet Mixed Conifer Fuels Reduction treatments. Mormon Mountain, FWPP 96
Table 41: Average stand values of no action and proposed alternatives projected 40 years for Wet Mixed Conifer Fuels Reduction treatments. Mormon Mountain, FWPP 96
Table 42. The number and percent of trees per acre in Alternative 2 over 18 inches dbh cut within the cable harvesting areas in the MSO PACs of Mormon Mountain, FWPP. Trees cut over 18 inches dbh are only those which occur in the cable yarding corridors. 98
Table 43: Current and Post Treatment..... 100
Table 44: Projected 20 Years* 100
Table 45: Projected 40 Years* 101
Table 46: The number and percent of trees per acre in Alternative 2 over 18 inches dbh cut within the cable harvesting areas in the MSO PACs of the Dry Lake Hills. Trees cut over 18 inches dbh are only those which occur in the cable yarding corridors. 103
Table 47: The number and percent of trees per acre in alternative 2 over 24 inches dbh cut within the cable harvesting areas in the MSO Recovery Habitat in the Dry Lake Hills, FWPP. Trees cut over 18 inches dbh are only those which occur in the cable yarding corridors. .. 105
Table 48 Current and Post Treatment..... 106
Table 49: Projected 20 Years* 107
Table 50: Projected 40 Years* 108
Table 51: Basal area and trees per acre for the Aspen Treatment areas under the Proposed Action Alternative. These numbers do not include anticipated aspen regeneration. Dry Lake Hills 110
Table 52: Acres and percent of currently allocated acres being managed for old growth by cover type and site potential, and the proposed acres for future old growth management located within FWPP. 111
Table 53: Current conditions and post treatment Dwarf Mistletoe Infection Level of ponderosa pine and mixed conifer as a percentage of stands with stand exams within FWPP 115
Table 54: Current and Post Treatment Ponderosa Pine and Mixed Conifer Beetle Hazard Ratings (Percent of stands in each Project Area)..... 116
Table 55: FWPP Cumulative Effects Project List of past, present, and reasonably foreseeable actions in the Dry Lake Hills project area and surrounding areas. 117
Table 56: FWPP Cumulative Effects Project List for past, present, and reasonably foreseeable actions in the Mormon Mountain project area and surrounding area. 118

List of Figures

Figure 1: General location of the project area in relation to Flagstaff and the two key watersheds.2
Figure 2: Two photos showing the historic change in forest conditions on the southwest face of Mt. The first picture was taken approximately 1895 and the second picture taken in 2013 12
Figure 3 Stratification of forested and non-forested lands 18
Figure 4: Map of Dry Lake Hills cover type within the Flagstaff Watershed Protection Project. 23
Figure 5: Map of Mormon Mountain cover type within the Flagstaff Watershed Protection Project..... 24
Figure 6: Existing old growth and designated developing old growth located within the Dry Lake Hills area..... 112

Figure 7: Existing old growth and designated developing old growth located within the Mormon Mountain area 113
Figure 8. Changes in stand density in southwestern ponderosa pine, non-reserved forest lands, NM and AZ (USDA Forest Service 2004). 121

Introduction

The objective of the project is to use mechanical thinning and prescribed burning on the National Forest to reduce the threat of high severity wildfire and subsequent flooding in two key areas near the City of Flagstaff, Arizona: the Dry Lake Hills portion of the Rio de Flag Watershed north of Flagstaff, and the Mormon Mountain portion of the Upper Lake Mary Watershed south of Flagstaff (Figure 1). The fuels reduction treatments proposed under this project would have effects similar to re-establish forest structure, pattern, and composition, within the ponderosa pine ecosystem which would lead to increased forest resiliency and function. Resiliency increases the ability of the ponderosa pine forest to survive natural disturbances such as insect and disease, fire, and climate change (FSM 2020.5). Other benefits of the proposed treatments include putting the project area on a trajectory towards comprehensive, landscape-scale restoration with benefits that include improved vegetation biodiversity, wildlife habitat, soil productivity, and watershed function.

Silviculture is the art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet diverse needs and values of landowners and society on a sustainable basis (SAF 1998). Forest vegetation composition, density, structure, and diseases such as dwarf mistletoe are the primary forest conditions which can be affected by silvicultural treatments. Stand composition can be altered with silvicultural treatments by manipulating a stand to create early seral[1] stage conditions.

The silviculture specialist report describes the existing vegetation condition and summarizes the forestland and cover types meeting definitions for Mexican spotted owl (MSO) and northern goshawk habitats. It compares those conditions to the desired vegetation conditions for the project area and illustrates the need for change. The report describes the proposed treatments and the effects of those treatments on the vegetation resource by characterizing the post treatment condition over time for each alternative. The report also evaluates each alternative in terms of moving toward the desired vegetation conditions.

The project was developed in consideration of the best available science. The best available science is a composite of the following key elements:

- On-site data and history. The project area was surveyed and Common Stand Exam data was collected.

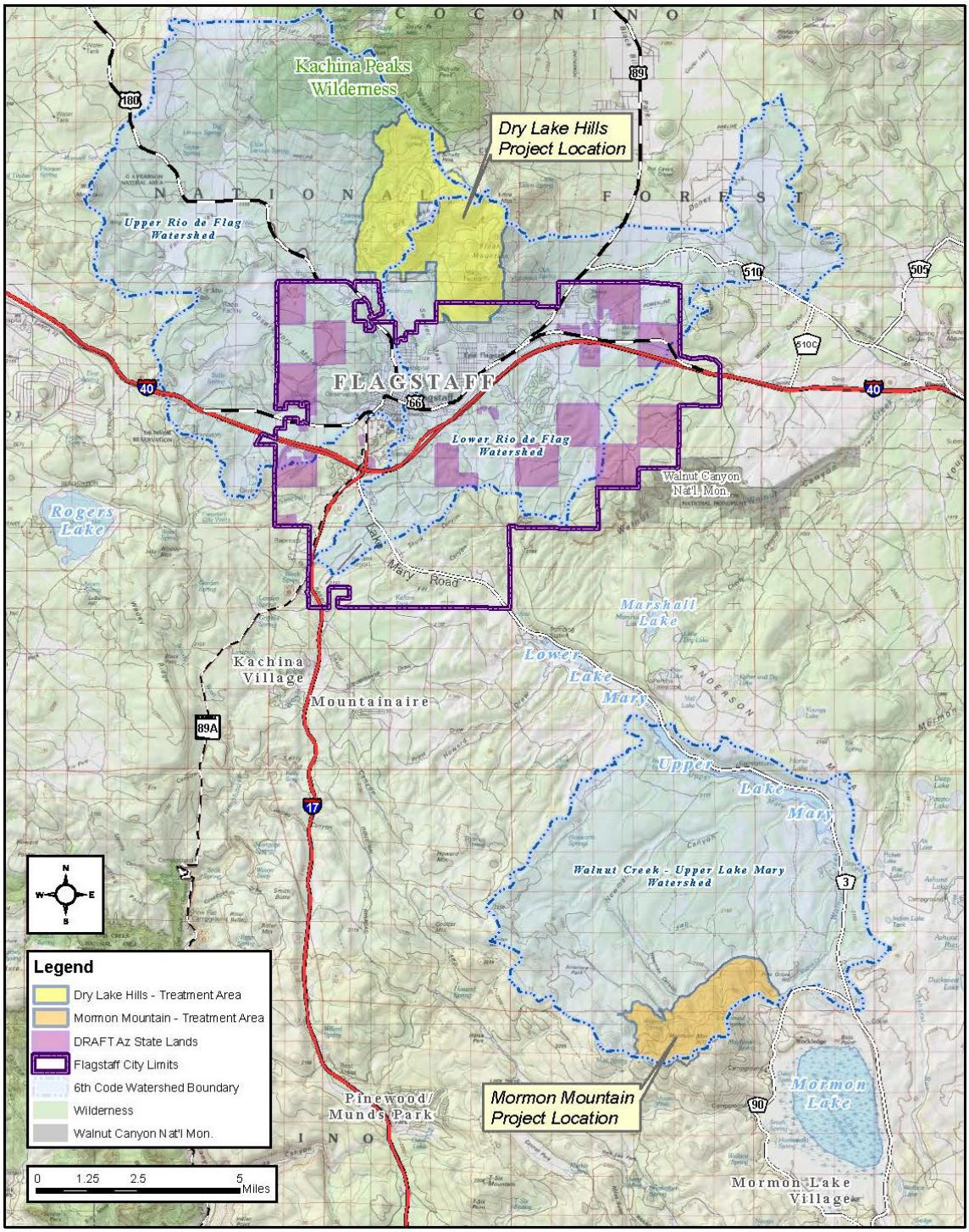
- Scientific literature. Literature reviewed and cited is listed in the appendix.

- Modeling using currently acceptable analysis. The vegetation management was analyzed using the current Forest Vegetation Simulation model. The model uses Stand Visualization Systems, and stand summary statistics to predict future stand structure, density, and composition.

- Professional knowledge, judgment and experience. The primary specialist who conducted the vegetation management analysis was Andy Stevenson. The analysis has been reviewed by resource peers. The collective professional knowledge of the project area, judgment of how to integrate science with local conditions, and the experience gained from implementation of other projects have been incorporated into the analysis.

[1] Seral – a temporal or intermediate stage in the process of succession (SAF 1998)

Figure 1: General location of the project area in relation to Flagstaff and the two key watersheds.



Overview of Issues Addressed

1. Restoration versus Fire Risk Reduction Issue: A common public concern voiced during scoping was the importance and sustainability of restoring ecosystems versus a purely fire-risk reduction approach to treatment because there is concern that a fire-risk reduction approach would result in unnecessarily departing from historical conditions that could be more sustainable long-term. This issue is addressed by incorporating reduced levels of treatment in Alternative 4. This report contains a discussion of which treatments are restoration-focused and which are designed for fire risk reduction, and why the focus may not be a strict return to historical conditions.

2. Mixed Conifer Issue: Several comments included concerns over what was perceived to be a proposal to change the Fire Regime of mixed conifer areas, the potential for vegetation conversion, and the differences between wet and dry mixed conifer vegetation types and treatments. This report includes discussion of the existing and desired conditions for the primary vegetation types in the project area, including but not limited to species composition, canopy cover, tree group size, basal area, trees per acre, and a discussion of how each alternative affects those conditions. This report contains an explanation of desired tree group size and basis for those ranges, as well as an explanation of wet and dry mixed conifer characteristics and locations.

   Several comments also voiced concerns over treatments proposed in mixed conifer vegetation types due to its relative rarity and importance to wildlife. This report includes discussion and clarification of where dry and wet mixed conifer occurs and the ecological need to treat in those areas. This report also discusses how treatments in those areas would differ from each other and from treatments proposed for ponderosa pine.

3. Conservation of Large (18" dbh+) Trees Issue: This issue is addressed in Alternatives 3 and 4 through a greater focus on the protection of large-diameter trees; in Alternative 3 by the absence of cable logging, and in Alternative 4 though a minimal treatment approach. The Silviculture specialist report details the estimated number of large (18" dbh +) trees that would be cut under each alternative, including for cable corridor locations where applicable. Additionally, design features to protect fire-scarred mixed conifer species, large oaks and alligator juniper will be added to the action alternatives.

Purpose and Need for Action

The purpose and need for proposing an action was determined by comparing the objectives and desired conditions in the Coconino NF Land Resource and Management Plans (Forest Plan) to the existing conditions related to the risk of high severity wildfire and subsequent flooding. Where plan information was dated or not explicit, local research and the best available science were utilized.

Silviculture Analysis Questions to be Answered and Key Issues Addressed

The following are analysis questions and corresponding evaluation criteria specific to the vegetation resource. These analysis questions will be tracked throughout the effects analysis in order to address whether, or to what degree, the project meets purpose and need objectives.

- How would treatments move vegetation structure towards desired conditions by creating a mosaic of openings and tree groups of varying sizes?
    - Acres by treatment intensity.
- How would treatments move towards a diverse forest structure with all age and size classes represented as identified in the 1996 forest plan amendment for northern goshawk and the 2012 revised Mexican spotted owl recovery plan?
    - MSO habitat size class representation; goshawk habitat structural stage representation.
- How would treatments sustain old age (pre-settlement) trees by implementing an old tree retention strategy?
    - MSO and goshawk habitat mature and old forest structural stage representation.
- How would treatments meet the objective of managing for old forest structure overtime across the landscape by moving towards forest plan old growth standards of 20 percent at a forest EMA scale?
    - Percent of area moving toward forest plan old growth criteria.
    - MSO and goshawk habitat mature and old forest structural stage representation.
- How would treatments improve forest health by reducing the potential for stand density-related mortality, by reducing bark beetle hazard and by reducing the level of dwarf mistletoe infection?
    - MSO and goshawk habitat forest density attributes and density zone characterization.
    - Percent of area by beetle hazard.
    - Percent of area by dwarf mistletoe infection level and average percent of trees infected.
- How would treatments move towards desired conditions for vegetation diversity and composition by maintaining and promoting mixed conifer, Gambel oak, aspen, and grasslands?
    - Acres of treatments that would maintain and promote mixed conifer, Gambel oak, aspen and grasslands.

Issues serve to highlight effects or unintended consequences that may occur from the proposed action, giving opportunities during the analysis to reduce adverse effects and compare trade-offs for the decision-maker and public to understand. Key issues pertaining to silviculture identified during scoping and the indicators used to evaluate the issue are:

- Quantitative pre-treatment and post-treatment three-level analysis for Mexican spotted owl, goshawk, old growth, and vegetation structural stage (VSS) for goshawk habitat at the landscape scale (ponderosa pine vegetation type) to gauge movement towards restoration desired conditions
- Pre-treatment and post-treatment distribution of habitat structure within goshawk habitat evaluated at three scales: project level, stand, and group (or point level, equivalent to a stand exam plot).

- Overall habitat structure (VSS class) and forest density metrics (basal area, stand density index and trees per acre) averaged to a per-acre basis with averages including openings, canopy gaps, and all forest structural stages.
- Density stocking guides that would be used to meet the VSS class canopy cover requirements within goshawk post-fledgling family areas (PFAs) and landscapes outside of post-fledgling family areas (LOPFA).

Area of Analysis

The project is located in two separate areas. The first area is comprised of the Dry Lake Hills and Mount Elden, and is approximately 7,569 acres. This this part of the project will be referred to as the Dry Lake Hills, or DLH for short throughout this document. The second area is located on the north slopes of Mormon Mountain and is approximately 2,974 acres. This area of the project will be referred to as Mormon Mountain or MM for short throughout the document.

Because of the geographic distance between the two project areas and the distinct habitat conditions of each area, this analysis will analyze each area independently.

Methodology, Assumptions and Limitations

Data Collection

The base unit for characterizing vegetation conditions is the stand. All lands within the Coconino National Forests have been delineated into stands based on similar characteristics such as vegetation type, slope, aspect, tree density, species composition and management history. Stands vary in size depending upon their uniformity, usually from 10 acres up to several hundred acres. Spatial and general vegetation information about each stand is stored in the stand database for the forest.

Comprehensive tree data has been collected on a subset of the stands within the project area over the last 30 years. Within each sampled stand, tree characteristics were measured at sample points, using both variable basal area factor plot and fixed plot designs. Specific tree data collected include species, class, diameter, height, age, growth, damage and disease. Other data sometimes collected, depending on design, include surface fuels and understory plant species. This stand data is currently stored in the Field Sampled Vegetation (FSVeg) database, which is a standard national (Forest Service-wide) database used to store field sampled data in a common format. A thorough review of the stand data was done for the project area to ensure validity. Data that did not match on the ground conditions or minimum sampling intensity was culled.

Tree data used within the DLH portion of the vegetation analysis of the forest areas within the analysis area came from stand exam data (discussed above) and by averaging stand data from adjacent stands to populate vegetative data to stands which stand exam data was not available. Within the MM portion, vegetation analysis came from stand exam data (discussed above) and the Most Similar Neighbor (MSN) Analysis computer program within the INFORMS model. The MSN analysis data used for this project (within the MM area) is from the same analysis that was conducted and generated by the 4FRI analysis. Refer to the 4FRI Silviculture specialist report for further explanation of the model and their analysis methods (McCusker 2012).

All of the stand data collected in 2013 or earlier was then compiled into a database and modeled in the Forest Vegetation Simulator (FVS) tree growth model and updated to the year 2013. This process allowed us to characterize the current stand conditions and determine the need for change and appropriate treatments based on the project purpose and need. A combination of field reconnaissance, GIS analysis and review of stand data was used to determine treatment needs, logging feasibility, and stand health (see the project record for more details on the development of the proposed action). The FVS was then used to simulate cutting and prescribed burning treatments and growth following treatment for each alternative up to the year 2053.

Modeling

The FVS is a model used for predicting forest stand dynamics throughout the United States and is the standard model used by various government agencies including the USDA Forest Service, USDI Bureau of Land Management, and USDI Bureau of Indian Affairs (Dixon 2002). The FVS is an individual tree, distance independent growth and yield model with linkable modules called extensions, which simulate various insect and pathogen impacts, fire effects, fuel loading, snag dynamics, and development of understory tree vegetation. FVS can simulate a wide variety of forest types, stand structures, and pure or mixed species stands (Keyser and Dixon 2008). Forest managers have used FVS extensively to summarize current stand conditions, predict future stand conditions under various management alternatives, and update inventory statistics.

Geographic variants of FVS have been developed for most of the forested lands in the United States. New "variants" of the FVS model are created by imbedding new tree growth, mortality, and volume equations for a particular geographic area into the FVS framework (Keyser and Dixon 2008). The Central Rockies (CR) variant covers all forested land in Forest Service Regions 2 and 3 and was used in the vegetation analysis for this project area. This variant was initially developed in 1990 and has been continually updated to correct known deficiencies and quirks, take advantage of advances in FVS technology, incorporate additional data into model relationships, and improve default values and surrogate species assignments (Keyser and Dixon 2008).

For simulation purposes, each data set was grouped by current forest type and treatment type. Simulations were developed for each treatment based on desired conditions. A multitude of vegetation and fuels attributes were computed for each growth cycle. Attributes included tree density (trees per acre, basal area and stand density index) by species or species groups and VSS size class, dwarf mistletoe infection, cubic feet of biomass removed, canopy base height and bulk density, live and dead surface fuel loading, live and dead standing wood, coarse woody debris and snags. These attributes were then averaged for all the data sets represented in the simulation. The averaged computed attributes from FVS were also used to calculate other attributes such as dominate VSS size class, canopy density and even-aged or uneven-aged structure. All of these attributes were then compiled into an "effects" database by alternative and used to analyze and display the direct and indirect effects to the vegetation resource.

The following is a list of general modeling assumptions. Table 1 and Table 2 list the modeling assumptions specific to each treatment type in the proposed action.

- All tree data was grown to the common year of 2013 and is considered to represent the existing condition.
- All tree cutting and removal was modeled in the year 2013.

- For those stands which would be burned, prescribed burns were modeled in the year 2016.
- After treatment, the tree data was grown to the common year of 2033 and 2053 and is considered to represent the post treatment condition.
- The tree data does not indicate tree age. Simulations use diameter as a surrogate for age based on the vegetative structural stage definitions. We acknowledge that there are trees on the landscape where age class overlaps size class. For example there may be young trees that are larger than 11.9" dbh; mid-aged trees that are larger than 17.9" dbh; or mature trees that are less than 18" dbh.
- The modeling assumptions attempt to meet the spirit of the 4FRI stakeholders Large Tree Retention Strategy (LTRS) within the limitations of a non-spatially explicit model. On the ground cutting prescriptions for alternatives 2 and 3 would follow components of the LTRS that have been incorporated into the design features of this EIS. Alternative 4 would include more specific limitations on large tree removal per the LTRS, as that alternative adopted a modified version of that strategy.
- All cutting simulations assume 15% of the cut stems are left on site and 10% of the branchwood from the cut and removed stems is left on site. All other biomass resulting from the cutting is assumed to be removed.
- Default parameters within the model were used to predict tree mortality and dwarf mistletoe infection intensification.
- Snags and coarse wood amounts are based on the inventory or default parameters within the model if they were not inventoried. Snag fall rates and changes in surface fuels are based on default parameters.
- In cutting simulations where cable yarding is proposed, approximately 10% of all species and size classes are cut to simulate the effect caused by the creation of cable corridors. All snags in cable yarding simulations are assumed to be cut and left in place due to operational safety requirements.
- In helicopter harvesting simulations, the analysis assumes that all snags in those units would be cut and left in place due to operational safety requirements.
- When calculating and averaging data, untreated areas were not averaged in with treatment areas.

Vegetative Structural Stage (VSS) Three Levels of Analysis

The analysis of VSS was conducted only in the goshawk habitat areas outside of MSO habitat.

Small Scale: For the small-scale VSS analysis stand exam data from all the stands with in the treatment area were analyzed using point (plot) level data. Points were evaluated and given a point-level VSS designation. The Forest Vegetation Simulator was used to calculate the average basal area per acre within each VSS class for each of these points. The point-level VSS designation represents the VSS class that contained the highest basal area. These point-level VSS designations, once evaluated and analyzed, were then used to conduct the small-scale analysis. The point level data was broken out into LOPFA, PFA, and nest groups. This analysis is displayed in Table 24.

Mid-Scale: For the mid-scale VSS analysis stand exam data from all the stands within the treatment areas were evaluated and given a stand-level VSS designation. The Forest Vegetation Simulator was used to calculate the average basal area per acre within each VSS class for each of these stands. The stand-level VSS designation represents the VSS class that contained the highest basal area. The list of VSS designations for each stand is too extensive to place in this document, but can be found in the project record. These stand-level VSS designations, once evaluated and analyzed, were then used to conduct the mid-scale analysis. The data was grouped by stands into LOPFA, PFA, and nest areas. This analysis is displayed in Table 25.

Landscape Scale: For the large-scale VSS analysis, all the stand level data for the entire goshawk habitat area was averaged to come up with one average value. Table 26 displays the large-scale analysis data.

Table 1: Proposed Action FVS Treatment Modeling Assumptions by Treatment Type in the Dry Lake Hills

Treatment Type	Target Basal Area	Thinning Cutting Control	Prescribed Burning	Regeneration
Aspen Treatment	N/A	Cut all conifers 0" to 9" dbh	2016 – very low intensity to remove dead and down only	No Sprouting due to no aspen cut
Burn Only	N/A	N/A	2016 – Low intensity; 70% of area; FFE estimates mortality	No sprout; No Regeneration simulated
Goshawk Nest Fuels Reduction	70 BA	Thin from below with reserves: Cut PP and MC 0" to 24" across diameter range to target BA of 70	2016 – Low intensity; 70% of area; FFE estimates mortality	No Sprouting; Natural regen of PP at 20 TPA, stands with MC receive natural regen of 50 TPA for each species.
Goshawk PFA Fuels Reduction	70-75 BA	Group Selection: In Pine; Leave 11 BA in VSS3, 17 BA in VSS 4, 19 BA in VSS 5. In MC; Leave 14 BA in VSS3, 19 BA in VSS 4, 22 BA in VSS 5 No trees over 24" dbh cut. Where cable harvesting methods are used 10% of all species and size classes are removed and higher residual BA is left to maintain target BA	2016 – Low intensity; 70% of area; FFE estimates mortality	No Sprouting; Natural regen of PP at 25 TPA, DF at 5 TPA
MSO Nest Fuels Reduction – Burn Only	N/A	N/A	2016 – Low intensity; 70% of area; FFE estimates mortality	No sprouting; No regen.

Treatment Type	Target Basal Area	Thinning Cutting Control	Prescribed Burning	Regeneration
MSO Nest Fuels Reduction – Hand Thinning	110 BA	Thin 80% of Conifers 0-5" dbh	2016 – Low intensity; 70% of area; FFE estimates mortality	No sprouting; No regen.
MSO PAC Fuels Reduction	80 BA	Thin from below with reserves 0-18" inches to 80 BA.	2016 – Low intensity; 70% of area; FFE estimates mortality	No sprouting; Natural regen for PP, MC spp. Aspen and Oak range from 5 to 50 tpa each depending on density.
MSO PAC Fuels Reduction – Hand Thinning	N/A	Cut most conifers 0" to 9" dbh. No oak or aspen cut.	2016 – Low intensity; 70% of area; FFE estimates mortality	No sprouting; No regen.
Mixed Conifer Fuels Reduction	60 BA	Thin PP and MC from Below with reserves 0-24" to target BA of 60. No oak or aspen cut.	2016 – Low intensity; 70% of area; FFE estimates mortality	No sprouting; Natural regen for PP, MC spp. Aspen and Oak range from 5 to 50 tpa each depending on density.
Mixed Conifer Fuels Reduction – Hand Thinning	N/A	Cut most conifers 0" to 9" dbh. No oak or aspen cut.	2016 – Low intensity; 70% of area; FFE estimates mortality	No sprouting; No regen.
Ponderosa Pine Fuels Reduction	45 BA	Group Selection: Leave 8 BA in VSS3, 8 BA in VSS 4, 11 BA in VSS 5. No trees over 24" dbh cut Where Cable harvesting methods are used 10% of all species and size classes are removed and higher residual BA is left to maintain target BA	2016 – Low intensity; 70% of area; FFE estimates mortality	No Sprouting; Natural regen of PP at 25 TPA, other MC spp at 5 TPA where they occur

Table 2: Proposed Action FVS Treatment Modeling Assumptions by Treatment Type in Mormon Mountain

Treatment Type	Target Basal Area	Thinning Cutting Control	Prescribed Burning	Regeneration
MSO Nest Fuels Reduction – Burn Only	110 BA	N/A	2016 – Low intensity; 70% of area; FFE estimates mortality	No sprouting; No regen.

Treatment Type	Target Basal Area	Thinning Cutting Control	Prescribed Burning	Regeneration
MSO Nest Roost Recovery – Thinning	95 BA	Cut PP throughout diameter range from 0-24. No oak cut.	2016 – Low intensity; 70% of area; FFE estimates mortality	No sprouting; Natural regen of PP and Oak at 25 tpa.
MSO PAC Fuels Reduction	80 BA	Thin from below with reserves 0-18" inches to 80 BA. No aspen or oak cut.	2016 – Low intensity; 70% of area; FFE estimates mortality	No sprouting; Natural regen for PP, MC spp. Aspen and Oak range from 5 to 50 tpa each depending on density.
MSO PAC Fuels Reduction – Wet MC	N/A	Jackstraw live and dead trees 0-18" dbh up to 10% of treatment area. Where cable yarding is occurring through Wet MC, 10% of all spp. and size classes are removed.	2016 – Very low intensity designed to remove dead and down.	Aspen Sprouting
Ponderosa Pine Fuels Reduction	50 BA	Cut only PP. Group Selection: 20% openings created, Leave 6 BA of PP in VSS3, 6 BA of PP in VSS 4, 10 BA of PP in VSS 5. No Oak Cut. No trees over 24" dbh cut	2016 – Low intensity; 70% of area; FFE estimates mortality	No Sprouting; Natural regen of PP and Oak at 25 TPA

Limitations

Stand exam data is an average characterization of tree and other measurements within the stand boundaries. It is limited by sampling intensity and the variability within the sampled area.

FVS is not spatially explicit and cannot model tree groups and openings within stands. The modeling results are an average approximation of the desired forest structure.

Results from the FVS model depend upon sample data, validity of the model itself and assumptions made by the modeler.

Output from the FVS model used in this analysis is a characterization of the existing condition and relative change over time of management actions or no action. Absolute conditions are neither intended nor implied.

Affected Environment

Existing Conditions

Historical Context

The existing vegetation condition has been shaped by natural processes and past human activities. The following is a summary of activities and processes that occurred during the last century and a

general discussion of how they influenced the existing forest structure, pattern, and composition within the project area.

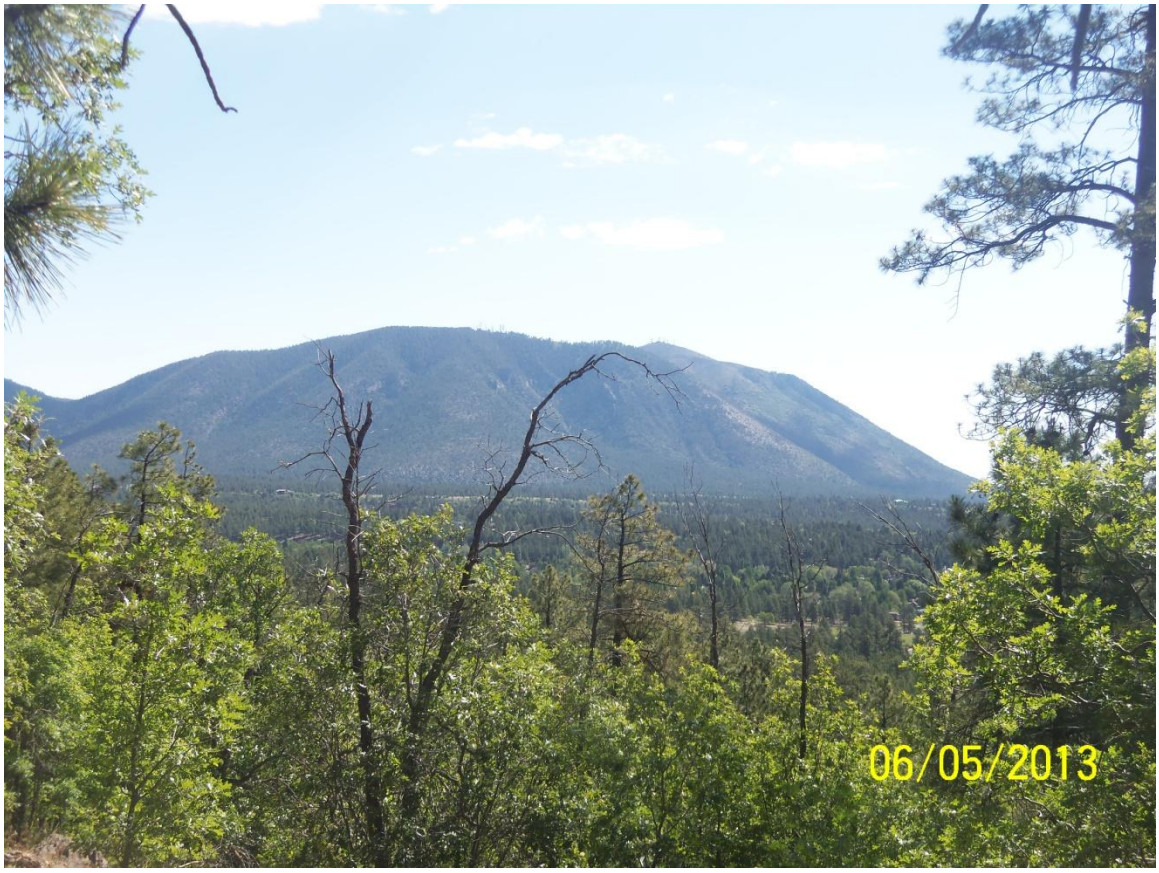
Historically, ponderosa pine and dry mixed conifer forests of northern Arizona were characterized by frequent, low-intensity surface fires occurring every 2 to 12 years in the ponderosa pine and 3 to 21 years in the mixed conifer. The historic fire regime maintained an open canopy structure and a variable, patchy tree distribution across much of the forest by thinning smaller trees (Moir et al. 1997, Covington et al. 1997, Heinlein et al. 2005). Prior to Euro-American settlement, ponderosa pine forests in the southwest were uneven-aged and consisted of fewer smaller diameter trees and a greater number of larger, older trees arranged in groups and interspersed with grassy openings. Figure 2 displays both a historic and a current photo of Mt Elden, which characterizes what the pre-settlement conditions were like and the conditions today. Additional historic photos can be seen in Appendix B. After Euro-American settlement, several conditions, including fire exclusion, livestock grazing, high-grade timber harvesting, and climatic events, favored dense ponderosa pine regeneration (Long and Smith 2000).

Within the ponderosa pine forests, much of the older age classes were removed during the railroad logging era and subsequent high-grade timber harvesting. In 1919, an unprecedented regeneration event occurred, resulting in massive amounts of pine seedlings. Due to fire suppression, these seedlings continued to grow in dense stands, forming a closed canopy across much of the landscape and effectively inhibiting further regeneration of shade-intolerant ponderosa pine. As a result of these factors, ponderosa pine forests of the southwest are now predominantly "even-aged" and consist of dense, overstocked stands of ponderosa pine with closed canopies and few trees less than 5 inches dbh or greater than 24 inches dbh.

Historic mixed conifer forests were typically uneven aged in structure, and tree spatial patterns varied from open and clumped to moderately-sized homogeneous patches. Density ranged from openings with very low density to patches with moderate density. As mentioned above, the warmer/drier mixed conifer forest types experienced more frequent fire and were typically uneven aged, growing in a patchy structure, contained many fewer trees per acre than existing stands and experienced relatively frequent low to moderate intensity fire, similar to ponderosa pine forests. The cooler/wetter mixed conifer forest types (referred to as "wet mixed conifer" in this report) historically experienced less frequent, moderate intensity fire, resulting in larger patches of homogeneous tree ages and higher patch density overall (Smith 2006). Wet mixed conifer vegetation types are found where historically fire occurred infrequently.

Due to the frequent disturbance regime, historic species composition in the warmer/drier mixed conifer forests was dominated by fire resistant, shade-intolerant conifer species such as ponderosa pine, southwestern white pine, and Douglas-fir. Historically shade-tolerant species were absent or present as a minor stand component on the drier sites such as ridge tops and southwest-facing slopes, with more abundant but still subdominant representation on cooler, wetter, north-facing slopes.

Figure 2: Two photos showing the historic change in forest conditions on the southwest face of Mt. The first picture was taken approximately 1895 and the second picture taken in 2013



According to the Coconino National Forest's historic initial entry timber atlas, the areas within the project north of Schultz Pass Road (FR420) were designated as part of a watershed protection area for the City of Flagstaff in the early 1900s. That designation along with limited access and steep slopes in the Dry Lake Hills and Mount Elden means that limited if any logging has occurred in the areas of mixed conifer forest. In the MM area there was a logging railroad spur to the top of the mountain. Logging of the pine and mixed conifer occurred on the less steep portions of the mountain. On the steeper slopes of the mountain (above approximately 35 percent slope) it does not appear that logging occurred in the mixed conifer or ponderosa pine.

Changes in historic fire regimes, along with other events that have occurred over the past century, has resulted in increased stand densities, changes in age and size class diversity, altered stand structure and species composition, changes in successional dynamics, altered insect and disease dynamics, decreased understory productivity and diversity, decreased tree health, growth and vigor, increased fuel accumulation and continuity, increased crown fire potential, and increased fire size and intensity (Long 2003).

From the late 1990s to the mid-2000s, there was a severe region-wide drought with the year 2002 being one of extreme heat and dryness. Monitoring showed an increase of tree mortality in ponderosa pine and mixed conifer forests. The results showed that the proportion of trees dying was greatest in large trees, particularly in mixed conifer. The level of mortality was greatest in the aspen and white fir species. In mixed-conifer forests, mortality in the largest size class (greater than 28 inches dbh) exceeded 22 percent from 2002 to 2007. (Gainey & Vojta 2011)

Past and ongoing treatments conducted within and adjacent to the Dry Lake Hill area of the project are displayed in Table 3. Around the turn of the century and in the early 1900s, high-grade timber harvesting was conducted within the project area mainly along the foot slopes and more easily accessible areas around the DLHs and Mt. Elden. Portions of the project area were logged again during the 1940s, '70s and '80s. Additionally, pre-commercial thinning took place in the '60s and '70s.

Table 3: Past and ongoing treatment history of the Dry Lake Hills

ACTIVITY	WHEN OCCURRED	PERCENT OF PROJECT AREA	EFFECTS
Livestock Grazing	1870s – 1985	100% and adjacent stands	Reduced understory abundance and productivity. Removed surface fuel. Disrupted the natural, surface fire regime. Contributed to increased regeneration. Grazing ceased altogether in the Dry Lake Hills sometime in the 1980s.
Commercial Thin	1940s, 1970s, & 1980s,	40% and adjacent stands	Reduced density of mid-aged and mature sawtimber and yellow pines. Decreased crown canopy closure. Contributed to increased regeneration and even-aged forest structure.
Precommercial Thin	1960s & 1970s,	20% and adjacent stands	Reduced density of young forest. Decreased crown canopy closure. Some improvement to forest health and fire hazard.
Fort Valley Project	1996 – Present	Adjacent stands to the south-east	Reduce density of young and mid-aged forest and create openings. Improvement to forest health, vigor, structure, growth, visual quality, fire hazard, and wildlife habitat. Thinning has been completed. Initial entry prescribed fire is ongoing.
Eastside Project	2007 – Present	Within and Adjacent stands to the south and east	Reduce density of young and mid-aged forest and create openings. Improvement to forest health, vigor, structure, growth, visual quality, fire hazard, and wildlife habitat. Majority of the treatments have been hand thinning.
Jack-Smith / Schultz Project	2009-present	11,827 acres within and adjacent to the north.	Reduce density of young and mid-aged forest and create openings. Improvement to forest health, vigor, structure, growth, visual quality, fire hazard, and wildlife habitat. The Orion Timber Sale is within the FWPP analysis area and is scheduled to start implementation in 2014
Radio Fire	1977	4594 acres within and adjacent.	This fire was a high severity fire which cleared a number of stands on the top of Mt. Elden. Several stands of aspen have regenerated. Post fire planting has had mixed success.

Dispersed Recreation	Ongoing	100% and adjacent stands	Affects localized soil conditions (compaction), visual quality (littering), and wildlife (user trails).

Past and ongoing treatments conducted within and adjacent to the Mormon Mountain area of the project are displayed in Table 4. Around the turn of the century in the 1920s, high-grade timber harvesting was conducted by railroad within the project area mainly along the foot slopes and more easily accessible areas around the mountain. Portions of the project area were logged again during the 1950s, '60s, '70s and '80s. Additionally, pre-commercial thinning took place in the '60s and '70s.

Table 4: Past and ongoing treatment history of the Mormon Mountain portion of FWPP

ACTIVITY	WHEN OCCURRED	PERCENT OF PROJECT AREA	EFFECTS
Livestock Grazing	1870s – present	100% and adjacent stands	Reduced understory abundance and productivity. Removed surface fuel. Disrupted the natural, surface fire regime. Contributed to increased regeneration.
Railroad Logging	1920s	60% and adjacent stands	Reduced density of mature sawtimber and "yellow" pines. Decreased crown canopy closure. Contributed to increased regeneration and an even-aged forest structure.
Commercial Thin	1950s, 1960s, 1970s, & 1980s,	50% and adjacent stands	Reduced density of mid-aged and mature sawtimber and yellow pines. Decreased crown canopy closure. Contributed to increased regeneration and even-aged forest structure.
Precommercial Thin	1960s, & 1970s,	30% and adjacent stands	Reduced density of young forest. Decreased crown canopy closure. Some improvement to forest health and fire hazard.
Mormon Lake Basin Fuels Reduction Project	Ongoing	2,831 acres to the south of the project	Reduce density of young and mid-aged forest and create openings. Improvement to forest health, vigor, structure, growth, visual quality, fire hazard, and wildlife habitat. The Mormon Lake Basin #2 Fuels reduction project is in progress.
Dispersed Recreation	Ongoing	100% and adjacent stands	Affects localized soil conditions (compaction), visual quality (littering), and wildlife (user trails).

Fire has been excluded and/or suppressed from the project area for over 110 years. From the 1970s to present, wildfires have occurred on approximately 500 acres within the Dry Lake Hills and on only three acres in the Mormon Mountain area in the last 20 years. Reforestation efforts in the early 1980s occurred after the Radio Fire (1977) on top of Mt. Elden but largely failed and as a result, the area is still in a grass/forb development stage.

Summary of the post-European settlement era ecological changes in terms of forest structure, pattern and composition

- Open, fire-maintained pine and mixed conifer forest structure has been altered by grazing, logging, and fire suppression.
- Large, old ponderosa pines have become rare in those pine stands which were logged in the past.
- The remaining large, old trees (ponderosa pine and mixed conifer) are suffering increased mortality rates as a result of competition with small trees.
- Ponderosa pine stands adjacent to areas of mixed conifer have experienced increased mixed conifer species regeneration and establishment within those pine stands.
- Ponderosa pine forests have increased in density as abundant tree seedlings have regenerated to infill canopy opening and replaced open, multiple age class structure with a dense dominant age class structure. This resulted from logging practices, protection from fire, reduction in livestock grazing, and a relatively wet climatic cycle (Schubert 1974).
- Competition for moisture and nutrients is intense in these dense stands, and results in stress that increases vulnerability to insect attack by such herbivorous insects as pine bark beetles (*Dendroctonus* spp.) and *Ips* beetles.
- Dwarf mistletoe has become more widespread in some areas due to closed forest conditions, greater canopy connectivity and lack of low severity fire.
- Potential fire severity has changed from low to mixed and high. The risk of stand replacing fires has increased.
- Severe burns often result in increased soil erosion and invasion by nonnative species.
- Stand-replacing wildfires on ponderosa pine sites have resulted in conversion from forest to grass or shrub perpetuated for long periods or dense, even age structure. These areas will not again support multi-aged pine forest for centuries.
- Coniferous trees have spread widely into grasslands and meadows.

Cover Types

Cover types are divided into three broad categories that describe vegetative state – non-vegetated, non-forest or forest. The following is a description of the cover types that occur within the analysis area. Table 5 below lists the acres within the analysis area by cover type. Figure 3 displays the breakdown of acres of MSO and Northern Goshawk habitat and their cover types.

and 5 show the locations of the cover type in the two project areas.

Table 5: Analysis Area Cover Type Acres

Cover Type	DLH	MM	Total
Non-Vegetated			
Barren (Right of Ways)	33	0	**33**
Non-Forest Communities			
Grassland	60	0	**60**
Forest Communities			
Ponderosa Pine*	4336	1924	**6260**
Mixed Conifer	3118	838	**3956**
Wet Mixed Conifer	0	213	**213**
Aspen	22	0	**22**
Total Forested Acres:	**7476**	**2975**	**10451**
Total Analysis Area Acres:	**7569**	**2975**	**10544**

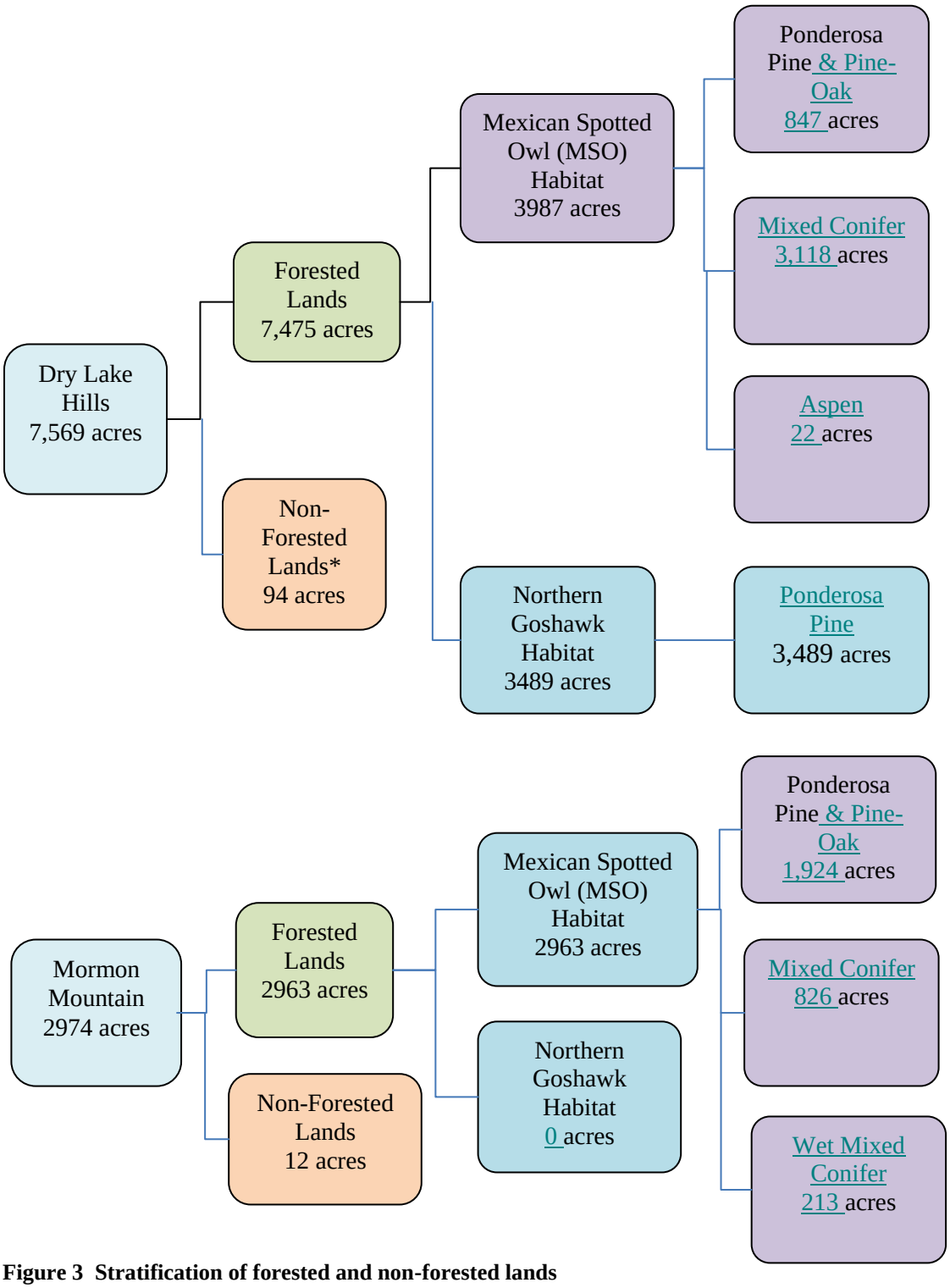


Figure 3 Stratification of forested and non-forested lands

Non-Forest Cover Types

Non-vegetated (Barren)

Includes Electronic sites, rights of way, mines, quarries, gravel pits and rock, talus or scree.

Grasslands

Laying in a patchwork across the Colorado Plateau, grasslands vary in size from just a few acres to well over 1,000 acres. Grasslands within the project area typically occur between 7,000 and 9,000 feet in elevation and are categorized as the productive Montane/Subalpine and the more arid Colorado Plateau/Great Basin. A wide variety of species of grasses, forbs, shrubs and/or trees characterize their vegetation which varies according to soil type, soil moisture, and temperature.

Historically, these grasslands had less than 10 percent tree cover. Impacts from grazing, logging, and fire suppression practices that started in the late1800s are still discernible on the landscape today. These practices reduced or eliminated the vegetation necessary to carry low-intensity surface fires across the landscape, thereby altering the natural fire regimes and allowing uncharacteristic forest succession to take place. These conditions have been further exacerbated by soil erosion, increases in invasive, nonnative plants and low-density rural home development.

Approximately 60 acres within the analysis area are classified as grassland cover type based on stand data.

The grassland cover type has experienced some degree of conifer (ponderosa pine and mixed conifer) encroachment over the last 100 years as a result of fire exclusion and grazing use. Many of the pre-settlement trees that grew along the edges of these grasslands were removed historically. These edges as well as much of the interior of the grasslands have become stocked by sapling and young to mid-aged trees. These trees are growing rapidly due to the open growing conditions and a lack of competition.

Forest Cover Types

Forest cover types are named for the tree species that are presently (not potentially) dominant, using canopy cover and basal area as the measure of dominance. Cover type is based on the species type which has the majority of dominance in the upper most layer of the site. The forest cover types have been grouped into communities (see next section).

Forest Vegetation Community

Ponderosa Pine (PP)

The ponderosa pine forest vegetation community within the project occurs at elevations ranging from 7,000 to 9,200 feet. It is dominated by ponderosa pine and commonly includes other species such as oak, juniper. Species such as aspen, Douglas-fir, white fir, limber pine and pinyon may also be present, but occur infrequently as small groups or individual trees. This forest vegetation community typically occurs with an understory of grasses and forbs, although it sometimes includes shrubs.

Ponderosa pine commonly grows in pure stands and currently is found in even-aged[2] and uneven-aged[3] structural conditions across the area. The open park-like stands characteristic of the reference conditions for ponderosa pine forests promoted greater faunal diversity and fire resilience than the dense stands of today. Ponderosa pine forests within the project are generally denser and more continuous than in reference conditions, and accumulations of forest litter and woody debris are much higher than would have occurred under the historic disturbance regime. Lack of fire disturbance has led to increased tree density and fuel loads that increase the risk of uncharacteristically intense wildfire and drought-related mortality. When fires occur under current conditions, they tend to kill a lot of trees, including the large and old trees. These trees take longer to replace, moving the forest further from desired conditions, and increasing the time it would take to return to desired conditions. There is a high risk of insect and/or disease outbreak, which is also a function of increased tree density (see Forest Health Section).

Gambel Oak within Ponderosa Pine Forest

Gambel oak is frequently the only deciduous tree in otherwise pure southwestern ponderosa pine forests, adding diversity to these forests. See

[2] Even-aged – pertaining to a stand composed of a single age class in which the tree ages are within + 20 percent variability based upon the mature stand age (SAF 1998).

[3] Uneven-aged – pertaining to a stand with trees of three or more distinct age classes (SAF 1998).

and Figure 5 for locations of pine-oak forest. A portion of the stands have a large enough component of Gambel oak to be considered pine-oak habitat for MSO (as described in the Forest Plan and MSO Recovery Plan). Similar to pure ponderosa pine forests, pine-Gambel oak forests have become altered since Euro-American settlement in the late 1800s resulting in an overall increase in small- and medium sized Gambel oak stems and a more simplified forest structure (Abella 2008). Oak management strategies within this project includes conservation of all existing large, old oaks, maintaining a variety of growth forms and managing for densities similar to the range of variability of oak's evolutionary environment.

Understory Vegetation within Ponderosa Pine Forest

Herbaceous vegetation (grass and forbs) are a major understory associate within the ponderosa pine plant associations throughout the analysis area. Research at the Fort Valley Experimental Forest has shown that substantial declines in herbaceous vegetation diversity and growth have occurred over the past century due to increased tree density, increased canopy covers, and increased forest floor depth (Covington et al 1997). This trend indicates a shift away from a more diverse balance across a broad variety of understory plants to productivity dominated by pine trees. The ponderosa pine analysis area is dominated by high stand densities and closed tree canopies.

Mixed Conifer (MC)

The mixed conifer vegetation communities within the project area occur from 7,200 to 9,200 feet elevation, and occur as two separate types, referred to in this report as "dry" and "wet." They are dominated by ponderosa pine, Douglas-fir, limber pine, and white fir. Aspen is an early seral species and occurs frequently throughout the mixed conifer areas. Limber pine does not occur in the Mormon Mountain portion of the project.

As referred to above, mixed conifer occurs in a continuum from warm-dry to cool-moist types. The most common species in the dry type include ponderosa pine, Douglas-fir, white fir, limber pine, Gambel oak, and aspen, while the wet types within the project area include white-fir, Douglas-fir, aspen, and maple. Dry mixed conifer types tend to be on lower north facing slopes or higher elevation south facing slopes and are more open than the wet types. The wet mixed conifer types typically occur at higher elevations and on north facing slopes. Historically the dry type experienced low to moderate intensity fire frequently. In the wet types, fires were less frequent but generally of a higher intensity and severity.

In dry and wet mixed conifer forests, habitat types are usually intermingled in relatively small areas, such as opposing aspects of the same hillside. The area of wet mixed conifer identified on

Mormon Mountain is a contiguous 213 acre area. Dry mixed conifer forests within the project are generally denser and more continuous than in reference conditions, and accumulations of forest litter and woody debris are much higher than would have occurred under the historic disturbance regime. Lack of fire disturbance has led to increased tree density and fuel loads that increase the risk of uncharacteristically intense wildfire and drought-related mortality. When fires occur under current conditions, they tend to kill a lot of trees, including the large and old trees. These trees take longer to replace, moving the forest further from desired conditions, and increasing the time it would take to return to desired conditions. There is a high risk of insect and/or disease outbreak, which is also a function of increased tree density (see Forest Health Section).

Wet mixed conifer forest within the project, may or may not be highly departed from reference conditions. The wet mixed conifer forest in this project does not contain any Engelmann spruce or sub-alpine fire. Wet mixed conifer forests that contain those two species are considered to be high severity stand replacing fire regimes. The wet mixed conifer in this project contains White Fir, Douglas-fir, scattered Aspen patches and occasional ponderosa pine which indicates that the fire regime may be that of a more mixed severity than stand replacing.

Quaking Aspen

Within the project area, quaking aspen is limited to small patches within a larger forest matrix dominated by ponderosa pine or mixed conifer vegetation. These patches consist of a few overstory trees with a sapling understory component. There is one 22 acre stand of pure aspen in the DLH which was created by post fire regeneration after the 1977 Radio fire.

Aspen reproduces asexually through root suckers that are a clone of the original parent tree. Fire, insect, disease, wind and human disturbances regenerate this shade-intolerant species by opening up the canopy and removing conifers from the understory. Without disturbance, conifers gradually overtop aspen, closing the canopy and eventually killing mature trees and reducing regeneration. Aspen is highly susceptible to browsing and disease or death due to bark injuries. Aspen patches are regenerating successfully where livestock and wildlife are excluded by fencing. Several aspen patches within the project area show signs of decline marked by mortality and dieback of crowns, similar to what has been observed across Arizona over the past several years (Fairweather et al. 2008).

Woodland species with in the Ponderosa Pine Forest

On slopes with southern aspects, scattered groups and individuals of woodland species may be found within the ponderosa pine forests. Species include pinyon pine, alligator juniper, one-seed juniper, rocky mountain juniper, and Utah juniper. These species have increased in density and spread over a wider area since the advent of Euro-American settlement and the suppression wildfires. Management strategies for woodland species within this project would include conservation of all existing large or old individuals, maintaining a variety of growth forms, managing for a range of densities and population locations.

Figure 4: Map of Dry Lake Hills cover type within the Flagstaff Watershed Protection Project.

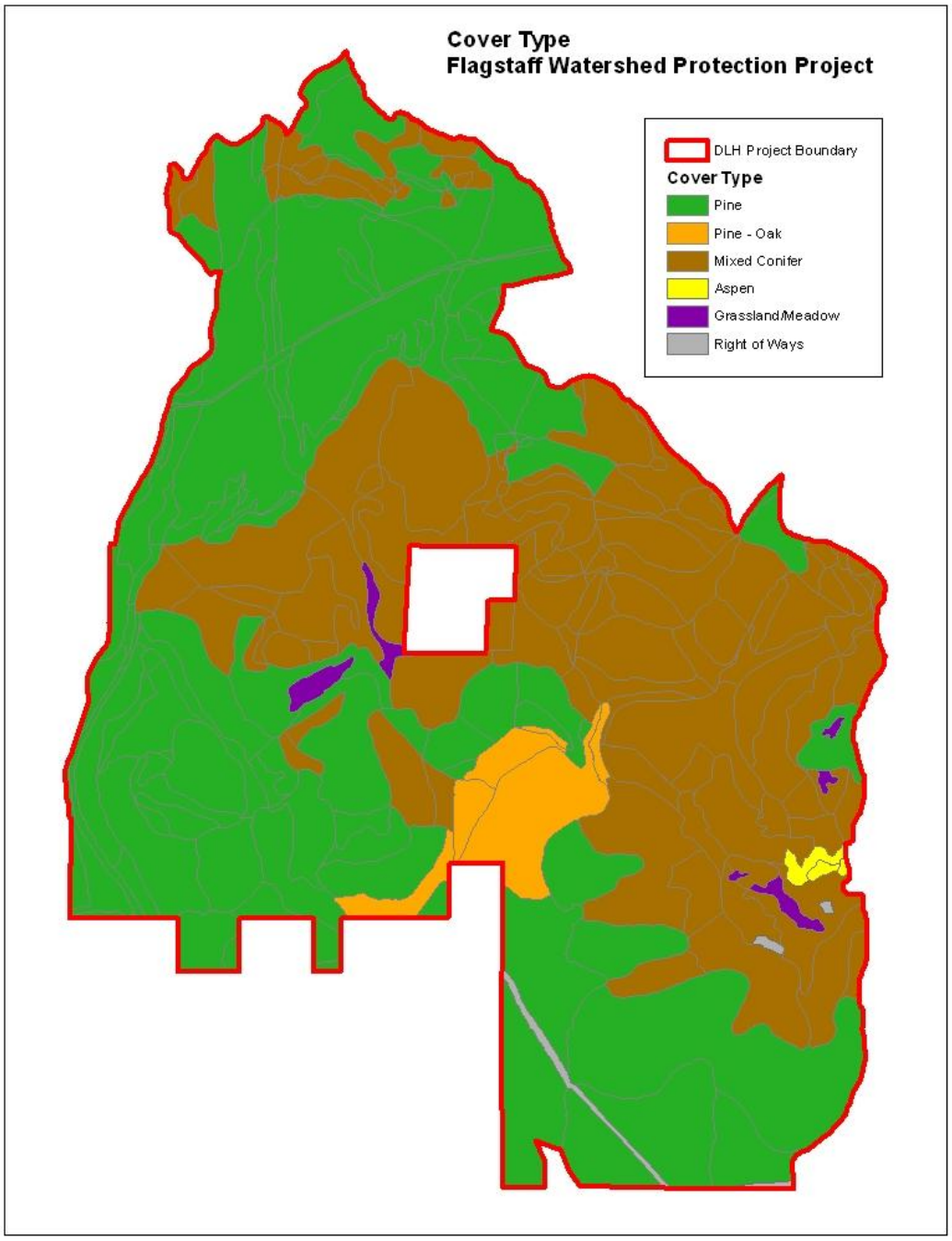
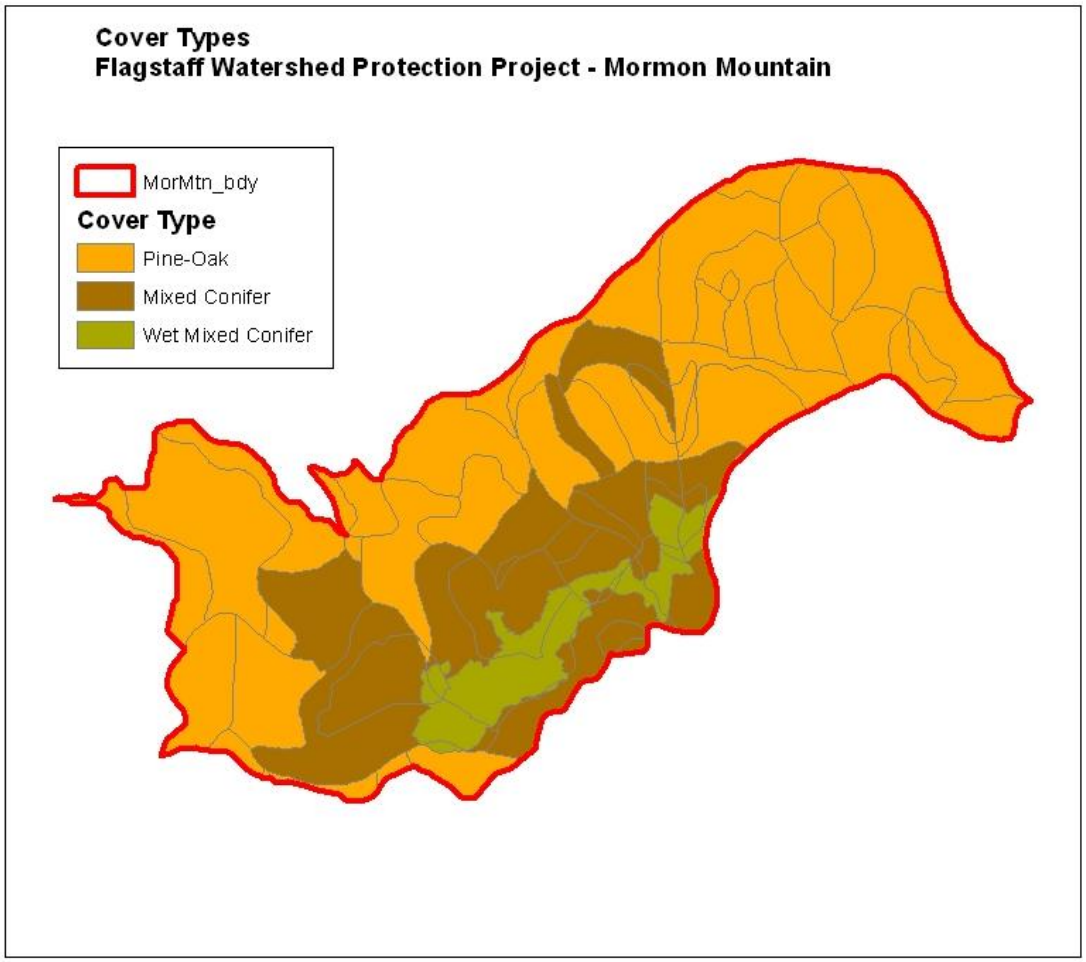


Figure 5: Map of Mormon Mountain cover type within the Flagstaff Watershed Protection Project.



Forest Structure (VSS, Density, Canopy Cover, Openness)

Vegetation Structural Stage Vegetation Structural Stage

Vegetation structural stage (VSS) is a method of describing the development stages of a stand of living trees and is a generalized description of forest age and tree size from seedling to old forests. It is an integrative approach, combining vegetation and forest growth, to describe southwestern forests. Six vegetation structural stages (VSS) have been defined primarily on tree diameters and are based on the time it takes seedlings to become established and subsequent growth rates. Life expectancy of trees determines how long the oldest VSS can be maintained (Reynolds et al. 1992). These stages are: VSS 1, forests dominated by grasses, forbs and shrubs; VSS 2, forests dominated by seedlings and saplings; VSS 3, young forests; VSS 4, mid-aged forests; VSS 5, mature forests; VSS 6, old forests (Reynolds et al. 1992). The VSS classification is based on the tree size class with the highest square foot of basal area. Basal area includes all tree species.

The VSS classification was further defined to include a measure of tree canopy density and age class heterogeneity along with the dominant diameter distribution. Age class is a measure of the variety of age classes present in relation to the dominant age class and is an indication of canopy layers. A single storied stand resembles an even-aged condition while multiple storied stands are

considered uneven-aged. Table 6 describes the VSS coding as defined by the Compendium of NFS Regional Vegetation Classification Algorithms (Vandendriesche 2010).

Table 6: Description of Vegetation Structural Stages (VSS)

VSS (DBH Size Class)	Structural Stage
1 (0-.9”)	Grass/Forb/Shrub
2 (1.0-4.9”)	Seedling/Sapling
3 (5.0-11.9”)	Young Forest
4 12.0-17.9”)	Mid-age Forest
5 (18-23.9”)	Mature Forest
6 (24”+)	Old Forest

Table 7 displays the acres by existing dominant VSS class for the ponderosa pine (outside of MSO recovery habitat) within the analysis area. All of the ponderosa pine in the Mormon Mountain part of the project has been identified as MSO recovery habitat and is not shown in the table below. Much of the landscape has a closed tree canopy, dominated by a single canopy layer and one age class. The young and mid-age structural stages account for approximately 85 percent of the ponderosa pine analysis area while the grass/forb and seedling saplings stages are zero percent, the mature tree stage is six percent and the old forest stage is nine percent. The low representation in the seedling/sapling, mature and old classes indicates limited structural stage diversity across the landscape with in the ponderosa pine.

Table 7: Existing Dominant VSS assessed at the stand level within Dry Lake Hills Ponderosa Pine outside of MSO recovery habitat.

Dominant VSS Class	Percent Of Analysis Area
1	0%
2	0%
3	34%
4	51%
5	6%
6	9%

For the remainder of the Silviculture report, the VSS classification will be used to stratify and characterize goshawk habitat. The full VSS code will not be quantified beyond what is disclosed in Table 7.

Density

Stand density[4] is the dominant factor affecting the health and vigor of conifer forests in the western US (SAF 2005). One of the major factors affecting forest structure and development, specifically the rate at which individual trees grow and advance through successional stages, is inter-tree competition. "Competition" refers to density-related scarcity of one or more environmental factors necessary for growth, such as moisture, nutrients, and sunlight. Early in stand development and prior to closure of the crown canopy, individual trees are growing at their full potential due to a lack of competition with other trees. As stand development advances, relative densities increase as the size of individual trees increase and the crown canopy begins to close. Individual trees begin to experience some competitive interaction with other trees and self-pruning of lower branches begins. At this stage in stand development, individual trees begin to exhibit height growth differentiation due to genetics, microsite differences, and damage caused by biotic and abiotic factors. As stands continue to develop, competition between trees continues to increase as trees increase in size. Growth rates for individual trees decrease as competition increases. Eventually, stands near the point of full site occupancy and self-thinning occurs due to competition-based mortality. At this stage of stand development, trees are growing at much less than full potential.

High forest densities result in increased inter-tree competition, decreased tree health, growth and vigor, decreased regeneration of shade intolerant species, stagnation of structural stage progression, increased insect and disease-related mortality especially in older age classes, decreased horizontal heterogeneity, decreased understory productivity and diversity, and increased fire hazard.

Measures of stand density used in this analysis are basal area, trees per acre and stand density index (SDI). Basal area (BA) is the cross-sectional area of all trees, measured in square feet per acre and trees per acre (TPA) is simply a count of the total number of trees on an acre. These simple measures of stocking do not give an indication of tree sizes and therefore can be biased when used to determine how site resources are being used.

Stand Density Index

SDI is a relative measure of stand density based on the number of trees per acre and the mean diameter (Reineke 1933). SDI expresses the actual density in a stand relative to the theoretical maximum density possible for trees of that diameter and species. By taking both tree size (DBH) and numbers (TPA) into account, SDI is a good indicator of how site resources are being used.

Those who use SDI, or any index of stand density, as an estimate of growing stock, must assume that the index is proportional to site utilization (Long and Smith 1984). Since the contribution of individual stand components to both total SDI and total site utilization is additive, SDI can be used to assess control of growing stock in uneven-aged stands as well as even-aged stands (Long and Smith 1984). Although SDI and the maximum size-density relationship were originally described for pure, even-aged stands, Long and Daniel (1990) have proposed extension of its utility to uneven-aged and multi-aged situations.

Long (1985) divided SDI percentages into four zones that consider the percent of a stand occupied by trees. Table 8 displays the amount of tree competition and growth based on stand

[4] Stand density – a measure of the degree of crowding of trees within stocked areas (SAF 1998)

density percentages (percent of maximum stand density index). Based upon established forest density/vigor relationships, density-related mortality from competition begins to occur once the forest reaches 45-50 percent of maximum stand density (zone 3), and mortality is likely at density levels of 60 percent or more of maximum stand density (zone 4).

Table 8: Relationships of Forest Density to Forest Stand Development and Tree Characteristics

% Maximum SDI*	Zone	Forest Stand Development and Tree Characteristics
0 – 24% Low Density	1	Less than full site occupancy, maximum understory forage production. No competition between trees, little crown differentiation. Maximum individual tree diameter and volume growth. Minimum whole stand volume growth.
25 – 34% Moderate Density	2	Less than full site occupancy, intermediate forage production. Onset of competition among trees, onset of crown differentiation. Intermediate individual tree diameter and volume growth. Intermediate whole stand volume growth.
35 – 55% High Density	3	Full site occupancy, minimum forage production. Active competition among trees, active crown differentiation. Declining individual tree diameter and volume growth. Maximum whole stand volume growth. **Upper range of zone marks the threshold for the onset of density-related mortality.**
56+% Extremely High Density	4	Full site occupancy, minimum forage production. Severe competition among trees, **active competition-induced mortality.** Minimum individual tree diameter and volume growth, stagnation. Declining whole stand volume growth due to mortality

*Ponderosa pine SDI max basis (450)

Based on these forest density relationships, a variety of stand and tree characteristics will develop by varying the timing, scale, and intensity of density management. A few examples follow:

- Grassy stands of open canopy, large-diameter trees with long, heavy-limbed crowns will develop by maintaining densities in zones 1 and 2.
- Stands of moderately dense canopy, intermediate-sized trees with thrifty, well-pruned crowns will develop by maintaining densities in the upper half of zone 2 and the lower half of zone 3.
- Clumpy, irregular stands containing groups of varying ages will develop by periodically making openings (regeneration group openings) where growing space is made available for seedling establishment. Growing space areas would fall into zone 1.
- Longevity of existing old-growth trees would be enhanced by thinning adjacent smaller trees to create zone 2 or 3 growing conditions.
- Avoiding density-related mortality and maintaining forest vigor can be achieved by maintaining densities at or less than the lower half of zone 3.

Canopy Cover

Canopy cover is defined as "the percentage of a fixed area covered by the crowns of plants delimited by a vertical projection of the outermost perimeter of the spread of foliage" (Reynolds et al. 1992). Canopy cover is often viewed as a meaningful expression of stand conditions relating to habitat suitability as well as tree overstory/herbaceous understory relationships. In the southwest, canopy cover estimates figure in management recommendations for both the Mexican spotted owl (USDI Fish and Wildlife Service 2012) and the northern goshawk (Reynolds et al. 1992). For this project, there are specific Forest Plan canopy cover guidelines for goshawk habitat and old growth that apply to mid-aged and old forest structural stages (VSS 4, 5, and 6) and not to grass/forb/shrub and young forest structural stages (VSS 1, 2, and 3).

Canopy cover is time consuming to measure and difficult to standardize to obtain consistent results with different observers. Even the definition of the term is dependent on the method of measurement. Percent canopy cover for all the analysis within this document was determined by stand using the average basal area (BA) as calculated by FVS. For small scale analysis BA was calculated by FVS at the point level. For mid-scale and large-scale analysis, BA was calculated by averaging the BA of all the points within that stand.
A study by Shepperd et al. (2002) used vertical crown projection to develop an algorithmic relationship to estimate canopy cover based on the average stand basal area. Average percent canopy cover for each stand was calculated using the following formula developed by this study:

$$Canopy\ cover = -57.44 + 25.5047 * LN(BA)$$

Initial FVS runs for mixed conifer stands calculated canopy cover values that were lower compared to observed canopy cover and may not reflect the true canopy cover in the stands themselves. Since canopy cover assessment includes not just the number and size of tree crowns, but also the spatial arrangements of the trees on the land, non-spatial models such as FVS and equations may not accurately reflect true conditions on the ground. To assess the canopy cover of mixed conifer, the crown width of ponderosa pine, Douglas-fir, white fir and limber pine were measured from trees within the project area in all size classes for each species. The crown widths were not significantly different between species. Based on this assessment, it was decided to use the above formula to calculate canopy cover from the average stand basal area.

While specifying the desired percentage distribution of VSS forest and canopy cover requirements, the Forest Plan is ambiguous on which scale measurements should be taken. The Forest Plan states that canopy cover guidelines should be applied to VSS 4-6 forest groups (Forest Plan p. 65-9), but does not specifically say at which level canopy cover should be measured to show compliance with this guideline. As a result, it is our professional judgment that canopy cover should be calculated at the group level to show that canopy cover requirements are meeting or moving toward canopy cover guidelines for VSS 4, 5, 6 forest groups. The Forest Plan also says that 'canopy cover is measured with vertical crown projection on average across the landscape (Forest Plan 65-9),' thus this NEPA document also discloses canopy cover measurements at larger scales for areas that also include forest groups in VSS 1, 2, 3.

Multiple VSS groups can be found within a single uneven-aged stand; therefore, a stand-level approach is not useful as it averages multiple VSS group structures and thereby classifies the stand as a single VSS class, which doesn't reflect the stand's uneven-aged characteristics. All openings are either considered in canopy cover calculations for VSS 4-6 or considered to be a part of VSS 1.

Table 9 lists the stocking guides that would be used to meet canopy cover requirements in tree groups within goshawk LOPFA habitat. Table 10 lists the stocking guides that would be used to meet canopy cover requirements in tree groups within goshawk PFA habitat.

Table 9: Stocking Guides to Meet Tree Group Canopy Cover Requirements within Goshawk Habitat Areas Outside of PFAs (LOPFA)

		Typical Number of Trees Per Group Stocking for Different Group Sizes[1]					Typical Intra-Group (within-group) Densities[1] (All Group Acreage Sizes)	
VSS	DBH Range	1/10 acre group	1/4 acre group	1/2 acre group	3/4 acre group	1 acre group	Relative Spacing Range (feet)	Basal Area[2] (ft^2/acre)
1 & 2	0 - 4.9”	19	48	96	144	193	12 – 18	N/A
3	5 - 11.9”	11	28	55	83	110	N/A	43
4*	12 - 17.9”	4	9	19	28	37	N/A	45
5*	18 - 23.9”	3	6	13	19	25	N/A	60
6*	24”+	3	6	12	18	24	N/A	95

[1]These are typical values for the desired condition; variation can occur and is desired. However, ranges should center on these values. See chart below.
[2]Rounded to nearest 10 square feet/acre.
* Densities are equivalent to 40% canopy cover.

Table 10: Stocking Guides to Meet Tree Group Canopy Cover Requirements within Goshawk PFAs

		Typical Number of Trees Per Group Stocking for Different Group Sizes[1]					Typical Intra-Group (within-group) Densities[1] (All Group Acreage Sizes)	
VSS	DBH Range	1/10 acre group	1/4 acre group	1/2 acre group	3/4 acre group	1 acre group	Relative Spacing Range (feet)	Basal Area[2] (ft^2/acre)
1 & 2	0 - 4.9”	19	48	97	145	193	12 – 18	N/A
3	5 - 11.9”	16	39	78	117	156	N/A	60
4*	12 - 17.9”	7	18	37	55	73	N/A	90
5**	18 - 23.9”	4	11	22	33	44	N/A	105
6**	24”+	3	8	15	23	30	N/A	120

[1]These are typical values for the desired condition; variation can occur and is desired. However, ranges should center on these values. See chart below.
[2]Rounded to nearest 10 square feet/acre.
* Densities are equivalent to 55% canopy cover
** Densities are equivalent to 50% canopy cover

Mexican Spotted Owl and Northern Goshawk Habitat

All ponderosa pine forested habitat within the analysis area was stratified to meet analysis requirements in the Forest Plan (USDA 1987, as amended) and the revised recovery plan for Mexican spotted owl (MSO). Stratification of acres by habitat and forest type is displayed in Table 11 (MSO) and Table 12 (goshawk). While both the DLH and MM areas have designated goshawk PFA’s and nests, only DLH has goshawk habitat outside of MSO habitat.

Table 11: Mexican Spotted Owl Habitat Stratification within the Analysis Area (Acres within each project site) under the 2012 MSO recovery plan.

MSO Habitat	DLH	MM	Total
Protected Activity Center			
Protected Activity Center (Outside of Nest/Roost Core)	1398	1772	3170
Nest/Roost Core	383	402	785
Total MSO PAC:	1781	2174	3955
Recovery Habitat			
Pine Oak	277	767	1044
Mixed Conifer	1800	0	1800
Nest/Roost	109	22	131
Total MSO Recovery Habitat:	**2186**	**789**	**2975**
Total MSO Habitat	**3967**	**2963**	**6930**

Table 12: Northern Goshawk Habitat Stratification within the Analysis Area (Acres by project site)

Northern Goshawk Habitat	DLH
Nest Habitat	45
Post-fledgling Family Area (PFA)	178
Landscapes Outside Post-fledgling Family Areas (LOPFA)	1739
Total Goshawk Habitat	**1962**

Forest Density and Structure – Mexican Spotted Owl Forest Habitat

The Protected Activity Centers (PACs) provide the best possible nesting/roosting owl habitat available with the nest or activity center located near the center. The recovery habitats are managed to ensure a sustained level of both foraging and nest/roost habitat distributed across the landscape. Table 13 displays the total basal area, percent of basal area by size class, tree per acre greater than 18" dbh and Gambel oak basal area as a percent of total basal for all MSO habitats. These structural attributes and habitat components are indicators of nest/roost characteristics as outlined in the revised MSO Recovery Plan (USDI FWS 2012).

MSO Nest Fuels Reduction & MSO Nest/Roost Recovery: Residual basal area would be a minimum 110 ft² in the Nest Cores and 95 ft² in Nest/Roost Recovery stands. Treatments would maintain a minimum of 60 percent canopy cover in mixed conifer. Post-treatment, a minimum of 12 trees greater than 18 inches dbh per acre would be present; trees greater than 12-18 inches dbh would comprise over 30 percent of stands, per the MSO Recovery Plan guidelines (2012).

Table 13: Existing Spotted Owl Habitat Forest Structure and Habitat Components

Habitat	Project Site	Cover Type	Basal Area	Avg. Percent of Basal Area by Size Class		Avg. TPA 18"+	Avg. Gambel Oak BA Percent of Total BA	Tons CWD	Snags >18"
				12.0 – 17.9"	>18.0"				
Recovery Habitat – Nest/Roost	DLH	Mixed Conifer	145	47%	10%	3.3	0%	37.6	3
	MM	Pine/Oak	173	17%	60%	39	14%	17.5	1.3
Recovery Habitat-Foraging Non-Breeding	DLH	Mixed Conifer	142	33%	28%	15	1%	23.3	3.7
		Pine/Oak	136	41%	30%	15.6	24%	13.4	.2
	MM	Pine/Oak	161	41%	26%	16	12%	11.8	.5
MSO PAC Habitat	DLH	Mixed Conifer	135	31%	28%	14	0.7%	26.9	4.0
		Pine	130	23%	63%	22	0	9.9	5.5
	MM	Mixed Conifer	153	23	39%	22	16%	27	9.2
		Pine/Oak	161	38%	20%	12.4	16%	14	.9
MSO PAC Habitat – Nest Core	DLH	Mixed Conifer	132	26%	36%	19	3%	25	3.3
		Pine	55	48%	36%	8	0	3.7	1.7
	MM	Mixed Conifer	140	23%	36%	20	18%	24	9.4
		Pine/Oak	146	45	17%	10	12%	11.2	0.5

Forest Density and Structure – Goshawk Forest Habitat

The post-fledgling family areas (PFA) consist of nest sites and adjacent habitat most likely to be used by fledglings during their early development as well as unoccupied suitable habitat within a 2 to 2.5 mile range of PFAs. The remaining ponderosa pine forest outside of MSO PACs, MSO recovery habitat areas, and goshawk PFAs is considered goshawk foraging habitat and will be referred to as Landscapes Outside of Goshawk Post-fledgling Family Areas (LOPFA) for the remainder of this report.

The existing distribution of forest structure, habitat components and structural stages within northern goshawk habitat was evaluated at three scales: Project extent, stand level, and plot level.

Table 14 and Table 15 display the existing forest structure and habitat components for goshawk forest habitat at the stand level. These structural attributes and habitat components are indicators of goshawk habitat (PFA and LOPFA) characteristics as outlined in the Forest Plan.

Table 14: Existing Goshawk Nest/PFA Habitat Forest Structure and Habitat Components

Project Site	Basal Area	Canopy Cover	TPA	SDI % of Max.	Snags >18"
DLH	137	70%	308	51%	1.2

Table 15: Existing Goshawk LOPFA Habitat Forest Structure and Habitat Components

Project Site	Basal Area	Canopy Cover	TPA	SDI % of Max.	Snags >18"
DLH	132	69%	314	54%	1.2

All goshawk habitat was assessed to determine the variety of tree size/age classes present in relation to the dominant size/age class (Table 16 and Table 17). Those stands with one or two classes present have even-aged structure, and those stands with three or more classes present have uneven-aged structure. Forest Plan direction for goshawk habitat outside of nest stands is to manage for uneven-aged stand conditions for live trees. Based upon this direction, the existing even-aged forest structure is not desired for goshawk forest habitat outside of nest stands.

Table 16 and Table 17 demonstrate the distribution of the dominate vegetation structural stages for all stands within each of goshawk habitats and age class strata. This is an indication of structural stage diversity throughout the goshawk habitat. Since the stand level structural stage is based on the tree size class with the highest square foot of basal area, it is a true description of age class diversity in even-aged stands; however in uneven-aged stands it does not give a complete portrayal. This is due to the fact that within uneven-aged stands, there are three or more age classes present and the dominant VSS class only tells us which one has the highest basal area.

Forest Plan direction for goshawk habitat outside of nest stands is the following distribution of vegetation structural stages: 10 percent each grass/forb/shrub (VSS 1) and seedling-sapling (VSS 2), and 20 percent each young forest (VSS 3), mid-aged forest (VSS 4), mature forest (VSS 5) and old forest (VSS 6).

The even-aged stands are dominated by the young and mid-aged forest structural stages (over 85 percent within the LOPFA and 80 percent in the PFA) with very little representation of the other structural stages.

The existing uneven-aged forest structure does not comprise a balance of VSS classes. The young and mid-aged forest structural stages are surplus, and the grass/forb/shrub, seedling-sapling, mature and old forest stages are deficit relative to Forest Plan direction.

Table 16: Existing Forest Structure – Goshawk LOPFA Stands Percent of Area by Vegetative Structural Stages.

Project Site	1 – Grass/Forb/ Shrub (0.0 - 0.9")	2 – Seedling/ Sapling (1.0 - 4.9")	3 – Young Forest (5.0 - 11.9")	4 – Mid-age Forest (12.0 - 17.9")	5 – Mature Forest (18.0 - 23.9")	6 – Old Forest (24.0" +)
DLH	0%	0%	32%	53%	8%	7%

Table 17: Existing Forest Structure – Goshawk PFA/Nest Stands Percent of Area by Vegetative Structural Stages.

Project Site	1 – Grass/Forb/ Shrub (0.0 - 0.9")	2 – Seedling/ Sapling (1.0 - 4.9")	3 – Young Forest (5.0 - 11.9")	4 – Mid-age Forest (12.0 - 17.9")	5 – Mature Forest (18.0 - 23.9")	6 – Old Forest (24.0" +)
DLH	0%	0%	41%	40%	0%	19%

Old Growth

The old growth specifications for ponderosa pine, mixed conifer and aspen cover types can be found in the Forest Plan on pages 70-72. Figure 6 and Figure 7 show the location of stands that meet the dentition of existing old growth. Table 18 shows the acres of existing old growth broken out by cover type and overall percent of each cover type that meets the current standard of existing old growth.

Table 18: Acres and percent of existing old growth by cover type and site potential located within FWPP. Cover Type and need for old growth are shown separately for the Dry Lake Hills and Mormon Mountain

Project Area	Cover Type	Acres of Cover Type	Acres of Currently Allocated	% Old Growth	Acres needed for 20%
Dry Lake Hills	Interior Ponderosa Pine – High	4336	1183	27%	0
	Mixed Species Group – High (Mixed Conifer)	3118	1450	47%	0
	Aspen	22	0	0%	4
Mormon Mountain	Interior Ponderosa Pine – High	1924	53	3%	332
	Mixed Species Group – High (Mixed Conifer)	1051	561	53%	0

According to the Forest Plan, old-growth forest should also be analyzed at multiple scales – one scale above and one scale below the ecosystem management areas. The three scales used to analyze old-growth for this project include:

- *Small scale* – at the stand level.
- *Mid-scale* - the ecosystem management area level. EMA was chosen due to Forest Plan direction.
- *Large scale* - across the Coconino National Forest.

This analysis only looks at the forest types that occur and would be managed in this project. They include ponderosa pine, mixed conifer, and aspen.

Small Scale: Individual stands were evaluated for existing old growth conditions and or suitability for managing towards old growth conditions. All MSO PAC stands, all nest/roost recovery habitat, and all goshawk nest stands were designated to be managed towards old growth conditions. Stand exam data was used to evaluate individual stands to determine if they were existing old growth or would have the potential to develop into old growth. This assessment was done for each of the cover types. It is also recognized that as goshawk LOPFA and PFA stands develop into uneven-aged stands, 20 percent of these stands would contain groups of old trees.

Mid-Scale: The DLH of the project occupies part of the Mt. Elden and Fort Valley Ecosystem Management Units (10K). Records indicate that 20 percent old growth has been allocated in the Mt. Elden and Fort Valley 10Ks. The allocation of areas to manage towards old growth conditions would change slightly in the Mt. Elden 10K due to better knowledge of cover type locations and stand conditions. The MM portion of the project partially occupies three different Ecosystem Management Units. Two of the 10Ks have exceeded the 20 percent allocation of needed for mixed conifer cover type. All three 10Ks are lacking adequate old growth allocation for ponderosa pine. The 4FRI planning process has already identified in excess of 20 percent of the ponderosa pine to be managed for old growth conditions. This project would adopt the same old growth allocations identified by the 4FRI planning process.

Landscape Scale: Across the Coconino National Forest, approximately 84,935 acres of ponderosa pine, 10,117 acres of dry mixed conifer, and 1,148 acres of aspen forest have been identified as existing or developing old-growth. These acres constitute approximately 11.0 percent of ponderosa pine, 22.7 percent of mixed conifer and 11.3 percent of aspen. The reason that less than 20 percent of the aspen and ponderosa forest types have been allocated towards managing for old growth conditions is because not all areas on the Forest have been analyzed since the implementation of the Forest Plan. As new vegetation projects are analyzed, more acres would likely be designated to be managed for old growth conditions.

Forest Health

For the purposes of this analysis, forest health is defined by the vigor and condition of the forest stands and the presence of insects and disease that affect the sustainability of the forest. A working definition of a healthy forest is a forest where:

- Native insect and disease activity is within the historic range of variability, and non-native insects/diseases are absent or incidental;
- Stand densities are at levels that facilitate overall forest development, tree vigor, and resilience to characteristic disturbances;

- Forest structure represents all age classes necessary for a sustainable balance of regeneration, growth, mortality and decomposition;
- Overall these conditions are resilient to natural biotic and abiotic disturbances (e.g., insects, diseases, fire, and wind).

Aspen

An accelerated decline of aspen occurred across the project area following a frost event in June 1999, a long-term drought that included an extremely dry and warm period from 2001 through 2002, and bouts of defoliation by the western tent caterpillar in 2004, 2005, and 2007. Surveys across the Coconino National Forest have shown that aspen on low-elevation xeric sites (<7500 ft.) sustained 95 percent mortality since 2000. Mid-elevation sites (7500–8500 ft.) lost 61 percent of aspen stems during the same time period; mortality is expected to continue in these sites because some remaining trees have 70 to 90 percent crown dieback.

According to the 2008 Fairweather et al. report, aspen on the Coconino National Forest have been in decline over the past decade. Several insects and pathogens were associated with aspen mortality but appeared to be acting as secondary agents on stressed trees. Aspen regeneration occurred to some degree on all the sites studied following the death of mature trees, although aspen sprouts were nearly nonexistent by the summer of 2007. This loss of spouts was attributed to browsing by elk and deer as none of the sites studied were grazed currently by domestic cattle. Widespread mortality of mature aspen trees, chronic browsing by ungulates, and advanced conifer reproduction is expected to result in rapid vegetation change of many ecologically unique and important sites (Fairweather et. al. 2008). The annual Forest Health Protection aerial survey conducted in 2010 (USDA FS 2011) indicated a continuation of the mortality trend within the project area.

Bark Beetles

An outbreak of bark beetles, starting in 2002 to 2003, resulted in widespread mortality across Arizona, including mortality in the project area. The outbreak was primarily the result of several native bark beetle species responding to the weakened condition of moisture-stressed, over-crowded forests. Trees on stress-prone sites were most affected. A decrease in affected acres began to occur in 2007 (USDA FS 2008).

The annual aerial surveys on the Coconino in the summer of 2012 detected mortality associated with bark beetles on approximately 517 acres within the project area. This mortality is most likely associated with the ips beetle and western pine beetle. The previous year's survey (2011) showed only one acre of mortality.

When trees are growing at high densities, there is a greater amount of inter-tree competition for resources like light, water, and nutrients compared with trees growing at lower densities (Kolb et al. 1998). Research in the West clearly shows that when trees are stressed from overstocking they are more susceptible to bark beetle attack (DeMars and Roettgering 1982, Schmid and Mata 1992, Schmid et al. 1994, Chojnacky et al. 2000, Negrón et al. 2000,). During the recent landscape-level bark beetle outbreak in Arizona, elevation and tree density were significant variables for estimating the probability of occurrence of mortality in ponderosa pine stands on several forests (Negrón et al. 2009). Dwarf mistletoe infection also appears to influence attack patterns of bark beetles on ponderosa pine during drought events (Kenaley et al. 2006, 2008).

A general bark beetle hazard model for southwestern ponderosa pine based exclusively on the tree density relationships developed in the *Dendroctonus* hazard model by Munson and Anhold (1995)

(as documented in Chojnacky et al. 2000) and the draft *Ips* hazard model developed by McMillin et al. (2011) indicates that stands of ponderosa pine within the project area with a relative density below 30 percent of SDImax have a low hazard rating and stands between 30 and 40 percent of SDImax have a moderate hazard rating. Using these relative density thresholds, approximately 11 percent of the DLH analysis area has a low bark beetle hazard rating, while 13 percent of the area has a moderate rating and the remaining 76 percent has a high hazard of beetle attack (Table 19). For the Mormon Mountain area, approximately 3 percent is rated at low hazard and the remaining 97 percent is rated as high hazard for bark beetle mortality.

Table 19: Existing Ponderosa Pine Beetle Hazard Rating (Percent of stands in each Project Area)

Cover Type	Hazard Rating	Dry Lake Hills	Mormon Mountain
Pine	Low	11%	3%
Pine	Moderate	13%	0%
Pine	High	76%	97%
Mixed Conifer	Low	0%	27%
Mixed Conifer	Moderate	5%	0%
Mixed Conifer	High	95%	73%

Dwarf Mistletoe

Dwarf mistletoes are the most widespread and damaging forest pathogens (disease-causing organisms) in the Southwest. Damage from dwarf mistletoes includes growth reduction, deformity—especially the characteristic witches' brooms, and decreased longevity. Infected areas often have much higher mortality rates than uninfected areas. Infection is often a major factor in mortality attributed to other damaging agents. For example, severely infected trees are often attacked by bark beetles (USDA Forest Service 2011).

Southwestern dwarf mistletoe infection in ponderosa pine is common throughout the ponderosa pine analysis area. On both the stand and landscape level, the distribution of dwarf mistletoes is usually patchy, with more or less discrete infection centers surrounded by areas without the disease. Infection centers expand very slowly, so overall incidence changes little from year to year (USDA Forest Service 2011).

Table 20 displays ponderosa pine dwarf mistletoe infection in terms of area by infection level for both ponderosa pine and mixed conifer. Within the mixed conifer, ponderosa pine and Doulas-fir are the two predominate tree species infected with mistletoe. The area with the highest level of infection is within the ponderosa pine in the DLH. Approximately 37 percent of the area is not infected or has a low infection level. Thirty four percent of the area is moderately or heavily infected. The remaining 29 percent is severely infected.

Table 20: EC - Dwarf Mistletoe Infection Level of ponderosa pine and mixed conifer within the Flagstaff Watershed Protection Area, Coconino National Forest.

Cover Type	Infection Level		Dry Lake Hills	Mormon Mountain
Pine	None/Low	Percent of Area	37%	69%
Pine	Moderate/High	Percent of Area	34%	31%
Pine	Severe	Percent of Area	29%	0%
Mixed Conifer	None/Low	Percent of Area	80%	91%
Mixed Conifer	Moderate/High	Percent of Area	20%	9%
Mixed Conifer	Severe	Percent of Area	0%	0%

Climate Change

Southwestern ecosystems have evolved under a long and complex history of climate variability and change. Taking into consideration the number of mega-droughts and other climate-related variation through time, southwestern systems have some built-in resilience. This project focuses on decreasing the risk of high severity fire while also attempting to restore and maintain resilience in forest and grassland ecosystems where possible. Risks of increased wildfire, insects and disease outbreaks, and invasive species represent ongoing, broad-scale management challenges. These issues are not new. However, climate change has the potential to increase and exacerbate the impacts of these ecosystem risks.

Based on current projections, the primary regional-level effects of climate change most likely to occur in the Southwest that would have an effect on forest vegetation include warmer temperatures, decreasing precipitation, and increased extreme weather events. These changes could result in immediate vegetation disturbance due to wind or flooding, increased wildfire risks, increased outbreaks of insects, diseases, and spread of invasive species, increased drought related mortality and changes in plant species composition.

Carbon - Climate scientists agree that the earth is undergoing a warming trend, and that human-caused elevations in atmospheric concentrations of carbon dioxide and other greenhouse gases are among the causes of global temperature increases. Forests serve as carbon reservoirs; however, large-scale fire events can counter this benefit by releasing significant amounts of carbon into the atmosphere and killing vegetation. Fuels reduction treatments (e.g., thinning, prescribed fire) as identified in the proposed action promote low-density stand structures, characterized by larger, fire-resistant trees. As similar projects move forward across the region, this strategy should afford for greater carbon storage in southwestern fire-adapted ecosystems over time (Hurteau and North 2009). Although fire-excluded forests contain higher carbon stocks, this benefit is outweighed in the long term by the loss that would be likely from uncharacteristic stand-replacing fires if left untreated (Hurteau et al. 2011). Research has also shown that the long-term gains acquired through prescribed fire and mechanical thinning outweighs short-term losses in sequestered carbon. In the long term (e.g., 100 years), thinning and burning would create more resilient forests that are less prone to stand-replacing events and subsequently able to store more carbon in the form of large trees.

Finkral and Evans (2008) examined the full effects on carbon of an actual restoration thinning treatment in a ponderosa pine forest. They found that while the treatment initially produced a 30-percent reduction in the carbon held in trees, it significantly reduced the threat of an active crown fire, which they predicted would kill all the trees and release 3.7 tons of carbon per acre in any untreated areas. Such findings are especially important when one considers that climate change is expected to make the conditions for catastrophic fire and insect outbreaks even more prevalent in the western United States.

Desired Conditions

Supporting Science

The project desired conditions have been developed based upon the project Purpose and Need and Forest Plan direction for forest vegetation management. Current best available science was used for analysis of conditions necessary to meet the project Purpose and Need. Science relative to historic reference conditions has informed this process.

The Desired Conditions for ponderosa pine forests incorporated information on the ecology of the overstory and understory vegetation comprising this type as well as information on its historic or natural range of variability in the composition, structure and pattern of vegetation.

Restoring southwestern ponderosa pine forests revolves around reintroducing a regime of frequent, low-intensity fires like those that historically maintained forest structure and function (Friederici 2004). Restoration treatments that include prescribed burning, often preceded by thinning to reduce fuel loads, have the potential to improve the ecological health of these forests. In order to wisely set the goals that underlie these treatments, it is useful for us to know as much as possible about past forest conditions, especially the "reference conditions" that existed before forest structure and function were altered by Euro-American settlers. Such conditions were not unchanging, but they sustained themselves across what has been called a "natural range of variability" (Friederici 2004).

The natural range of variability (NRV) specific to the Flagstaff Watershed Protection Project area comes from early written records, general land office surveys, Forest Service records, oral histories, and photographs as well as old forest remnants, physical remains of old trees and dendrochronology. For example, Cooper (1960) researched the cultural evidence to document the historic condition of southwestern pine forests. Many early travelers, surveyors and government officials left records of their impressions of pine forest country specific to the project area. The 19th century descriptions of ponderosa pine forest conditions by the likes of Lt. Edward Beale, Lt. Ives, C. Hart Merriam, J.B. Lieberg, S.J. Holsinger could be summarized as follows: "The forest was decidedly open and park like; reproduction was not abundant, and in many areas was markedly deficient; grass was abundant but not universal" (Cooper 1960). Other documentation that has informed our current understanding of the NRV includes plot data by early scientists (Woolsey 1911, Pearson 1950), tree ring, dendrochronological, and restoration studies (Covington and Moore 1994, Swetnam and Baisan 1996, Covington et al. 1997), natural area and old growth studies (White 1985), and wildland fuel management strategies (Pearson 1950, and Fule et al. 1997). The following is a NRV description based on these and many other references.

Natural Range of Variability

All southwestern forests and woodlands are periodically affected by natural disturbances such as fire, insects, disease, wind, and herbivory (Mast et al. 1998 and 1999, Brown et al. 2001, Ehle and Baker 2003). These disturbances have variable effects on forest vegetation depending on the type,

frequency, intensity, and spatial scale of disturbances. The type, frequency, and intensity of disturbances varied historically among forest and woodland types. A forest or woodland's characteristic composition, structure, and landscape pattern, the result of vegetation establishment, growth, and succession, combined with the periodic resetting of these by characteristic natural disturbances, constitutes a forest or woodland's natural range of variability. The temporal and spatial variability in vegetation establishment, growth, and mortality, and the consequences of natural disturbances in a forest or woodland define the natural range of variability. Much of the range of variability stems from fine- to landscape scale heterogeneity in aspect, slope, elevation, and soils that can lead to topographically different growing conditions and disturbance regimes (Fule et al. 2003). The ability of a forest ecosystem to absorb and recover from disturbances without drastic alteration of its inherent function is central to the concept of natural range of variability. In the southwestern United States, fire is a primary disturbance agent and fire regimes are central to understanding natural range of variability as it relates to the composition, structure, and pattern in various forest types (Fule et al. 2003).

Species Composition

In this type, ponderosa pine is the dominant seral and climax tree species, but depending on locale may mix with gamble oak, several juniper and pinyon species, quaking aspen, Douglas-fir, limber pine, white fir, or white pine (USDA 1997). Composition of the grass/forb/shrub understory is typically diverse in ponderosa pine forests, especially when canopy openings are present (Moir 1966, Naumburg and Dewald 1999, Laughlin et al. 2006, Abella et al. 2011). Presence of shrubs is variable depending on habitat type and locale (USDA 1997). While grasses and herbs occur in most ponderosa pine types (USDA 1997), the composition, abundance (cover), and productivity is variable depending on soil, aspect, elevation, latitude, moisture, and the presence or absence of tree cover (Moir 1966, Naumburg and Dewald 1999, Laughlin et al. 2006, Abella et al. 2011).

Tree Density and Distribution

Historical tree densities on reconstructed plots throughout the Southwest varied depending on factors such as elevation, aspect, slope, soils, moisture, and a site's unique history. An example of this was a reconstruction study involving 53 2.5-acre plots representing nine different ponderosa pine ecosystem types near Flagstaff, Arizona. Historical tree densities on these sites varied 19-fold, and averaged between 2 -40 trees per acre (Abella and Denton 2009). Moore's et al. (2004) reconstruction study on their 15 2.5 acre Woolsey plots estimated a mean density of 40 trees per acre based on live tree and cut-stump BA (Moore et al. 2004). On the same Woolsey plots, Sanchez Meador et al. (2010) found that the number of tree groups ranged from 4-11 per acre and ranged in size from 0.004 ac to 0.06 acre. Other reports of historical tree densities include 22 trees per acre near Walnut Canyon (Menzel and Covington 1990), 23 trees per acre at Bar-M-Canyon (Covington and Moore 1994), 24 trees per acre on the Gus Pearson Natural Area (GPNA) on the Fort Valley Experimental Forest (Mast et al. 1999), and 24 trees per acre at Camp Navajo (Fule etal. 1997). A 1938 forest inventory on the long Valley Experimental Forest (central Arizona) showed that 75 trees per acre were present prior to the cessation of frequent fire (between 1880 and 1900). Woolsey (1911) reported an average of 18 trees per acre (> 4 inches dbh) in northern Arizona in the early 20th century. Typical historical tree groups ranged from 0.1 to 0.75 acres in size and comprised 2 to 40+ trees per group (White 1985, Fule et al. 2003, Covington et al. 1997). Restoration studies on the Fort Valley Experimental Forest near Flagstaff, Arizona, showed an average of 23 trees per acre that were grouped into distinct 0.05- to 0.7-acre groups consisting of 2-40 trees (Covington et al. 1997).

Structural characteristics widely reported for historical Southwest ponderosa pine are relatively open forests with trees typically aggregated in small groups within a grass/forb/shrub matrix (Cooper 1960, White 1985, Pearson 1950, Covington et a1.1997, Abella and Denton 2009). Recent work in northern Arizona has shown that tree densities across nine different ponderosa pine ecosystems depended to a large extent on soil type and climatic variables such as minimum spring and fall temperatures, and May precipitation (Abella and Denton 2009). This work also showed that the degree to which trees were aggregated into groups was largely explained by ecosystem soil type. Twenty-eight to 74 percent of all trees were in groups; the remaining trees were scattered individuals (Abella and Denton 2009). These structural conditions were maintained by frequent low-intensity surface fires that more often killed small rather than large trees (Weaver 1951, Fiedler et al. 1996, Cooper 1960). Other small-scale disturbances such as insects, disease and others also shaped this characteristic forest structure. Low intensity fires occurred every 2 to 12 years and maintained an open canopy structure (Covington et al. 1997, Moir et al. 1997). The grass/forb/shrub understory and fine fuels (needles, cones, limbs) from large trees fueled these frequent fires started by lightning and, to an uncertain extent by Native Americans (Kaye and Swetnam 1999, Allen et al. 2002). Regular fire thinned or eliminated thickets of small trees, resulting in open, park-like forests (Cooper 1960, Covington et al. 1997, Allen et al. 2002).

While the ponderosa pine forest of northern Arizona have been widely studied and researched, the mixed conifer forest within northern Arizona have not been as widely studied or researched. However there are a growing number of studies within the mixed conifer forest across the southwest Colorado Plateau that provide historic reference conditions. The studies show a much wider variation in historic mixed conifer forest conditions compared to ponderosa pine. The two most relevant studies to this project were conducted on the San Francisco Peaks (Heinlein et. al. 2005 and Cocke et. al. 2005). The Heinlein study looked at two studies on the San Francisco Peaks between 7800 and 8800 feet. The study shows that the historical mixed conifer stands were dominated by ponderosa pine and tree densities averaged 21 trees per acre. The Cocke study also took place on the San Francisco Peaks between 8000 and 11700 feet; the mixed conifer portion of the study found historical conditions of 65 trees per acre.

Forest Openings and the Grass/Forb/Shrub Vegetation Matrix

Woolsey (1911) described late 19th century southwestern ponderosa pine forests as follows: "The typical western yellow (ponderosa) pine forest of the Southwest is a pure park-like stand(s) made up of scattered groups of from 2 to 20 trees, usually connected by scattering individual. Openings are frequent and vary in size. Because of the open character of the stand and the fire-resisting bark, often 3 inches thick, the actual loss in yellow (ponderosa) pine by fire is less than with other, more gregarious species."

Others also described historical ponderosa pine forests as having low tree density, open, savanna-like stands consisting of groups of pine trees interspersed with grassy or shrubby openings (White 1985). The actual degree of "openness" has received little measurement; instead, most reconstruction/restoration studies focused on tree densities and tree aggregation. Although White (1985) did not define how close trees had to be to constitute a "group" (he used the absence of 1919 regeneration beneath large tree crowns to define groups), he reported 22 percent of his plot on the GPNA was under tree groups. Thus, 78 percent of the 18 acre area would likely have been open before the 1919 regeneration pulse (White 1985). White (1985) reported that 12 percent of the historical trees on his plot were not in groups of three trees; if he had included single trees and groups of 2 trees, the percent open would have been less than 78 percent. Covington et al. (1997), also working on the GPNA, reported that while canopy cover was high within groups of trees,

only 19 percent of the surface area of their study plot was under pine canopy; the balance (81 percent) represented grassy openings (Covington et al. 1997). Where crown cover was not reported, Gill's et al. (2000) mean crown radius for mature ponderosa pine (19.7 feet) can be used to estimate area under crowns. Of the 53 study plots in Abella and Denton (2009), those with only two trees had less than 2 percent under tree crown (98 percent open). At the opposite extreme, a plot with 40-trees had an estimated 28 percent under crowns (72 percent open). Using the same approach on the Long Valley Experiment Forest, for the 75 trees present before the cessation of fire (about 1900) resulted in about 52 percent of the per acre area under tree crowns (48 percent open). Sanchez Meador (Sanchez Meador et al. 2011 found a similar range between 10 and 30 percent on reconstructed Woolsey plots located throughout Arizona and New Mexico.

Sustainability and Resilience

Knowledge of the historical forest composition and structure on a site can provide estimates of forest composition, structure and pattern that was resilient to disturbance agents (insects, fire) and sustainable through at least several generations of trees (Allen et al. 2002, Abella et al. 2011). It may not be necessary, or even desirable in some cases, to have desired conditions that are within the natural range of variability at every site in southwestern forests and woodlands. However, historical conditions are more synchronous with the natural disturbance regime to which the forest and woodland ecosystems are adapted. Social, political and economic factors are much different today than a century ago and there are valid considerations for leaving areas of higher or lower tree-density or differing composition to meet resource management needs. But restoration on some portion of the landscape to conditions reminiscent of pre-European settlement times would most likely provide for greater biodiversity, and greater ecosystem productivity, stability, sustainability, and services.

Desired Conditions - General

A variety of forest conditions (composition, structure and pattern) exist across the landscape, comparable to historic conditions. Forested landscapes are diverse with groups and patches of variable tree densities, including groups with dense, closed canopies (interlocking crowns) and small areas of scattered individual trees; well shaded soil beneath tree groups; dead, deformed and diseased trees; large logs and woody debris; and old, large oaks, junipers and aspen. Canopy openings within the forest are common and support a diverse species composition and productive grass/forb/shrub community. Openness ranges from very open within the savanna and grassland matrix to closed on the highly productive forest sites to achieve a heterogeneous condition across the forested landscape. Forest habitats contain a forest overstory dominated by ponderosa pine, mixed where appropriate with pinyon and juniper species, oaks, aspen, Douglas fir, limber pine or white fir. Large old alligator junipers continue to exist where they currently occur. .

Overall, the project area comprise forest conditions that are resilient to disturbance (insects, disease, fire, climate change) and sustainable through at least several generations of trees. Forest habitats are generally vigorous, with endemic levels of native insect and disease occurrences.

Dwarf mistletoe is an element of the forest landscape. There is a varied level of mistletoe across the landscape, comparable to historic conditions. Forest structure and density impedes spread and reduces impacts associated with infection. Desired stand dwarf mistletoe infection levels do not exceed 20% infection of the host species (trees per acre basis), or 25% of the area infected for any given tree species (Conklin and Fairweather 2010). Dwarf mistletoe infections are irregularly distributed among tree groups, such that effects are limited to the forest group and patch scale.

The ponderosa pine and dry mixed conifer forest are uneven-aged and composed of a distribution of age classes that comprise a sustainable balance of structural stages. Old trees and old forest structure is common and sustained over time across the landscape. In dry mixed conifer areas outside of MSO PACs and nest roost recovery habitats, basal areas average less than 80 ft²/acre. In wet mixed conifer areas forest are uneven-age and diverse species composition is maintained by large and small scale disturbances and early seral species are well represented.

Fully stocked, healthy forest conditions facilitate capacity to store carbon and minimize tree losses to wildfires, insects, and diseases. Forests within the project area provide a sustainable supply of diverse uses and values while contributing to the stabilization of carbon released into the atmosphere.

Ponderosa Pine

*Ponderosa Pine Goshawk Habitat Restoration within LOPFA Areas**

Desired future conditions include increased diversity in age and size classes, uneven-aged stand structure, and improved successional dynamics. Distribution of vegetative structural stages (VSS) is: 10 percent grass/forb/shrub (VSS 1), 10 percent seedling-sapling (VSS 2), 20 percent young forest (VSS 3), 20 percent mid-aged forest (VSS 4), 20 percent mature forest (VSS 5), and 20 percent old forest (VSS 6). (*LOPFA areas in this project are all ponderosa pine stands outside of northern goshawk post fledgling areas and Mexican spotted owl protected activity centers.)

Desired future conditions for the LOPFA areas include groups of 2 to 40 trees ranging in size from 0.1 acre to .7 acre, with openings between groups. Canopy cover within VSS 4-5-6 groups would vary from 40 percent to 70 percent. . At the group level, basal areas would average 50 ft² per acre or greater in VSS 4, 5 and 6 groups. Stand density indices would be below 35 percent of SDImax over the majority of the area.

All yellow pines would be retained. All snags greater than 12 inches diameter would be retained, 3 downed logs greater than 12 inches diameter and at least 8 ft. long, and 5-7 tons of woody debris greater than 3 inches in diameter would be retained per acre. Regeneration openings from .1 to 4 acres would be created across 20 percent of each stand. Regeneration openings up to 4 acres with a maximum width of 200 feet may be created; however openings should rarely be greater than two acres and the average opening size is approximately one acre. Regeneration openings would comprise up to 20 percent of each stand. Three to five trees per acres would be retained in openings greater than one acre.

Ponderosa Pine Restoration within Northern Goshawk Post Fledging Areas (PFA)

Desired future conditions include increased diversity in age and size classes, uneven-aged stand structure, and improved successional dynamics. Distribution of vegetative structural stages (VSS) is: 10 percent grass/forb/shrub (VSS 1), 10 percent seedling-sapling (VSS 2), 20 percent young forest (VSS 3), 20 percent mid-aged forest (VSS 4), 20 percent mature forest (VSS 5), and 20 percent old forest (VSS 6). Tree groups in VSS 4 would average 1/3 60 percent and 2/3 50 percent canopy cover.

Desired future conditions for PFAs include groups of 2 to 40 trees ranging in size from 0.1 acre to .7 acre, with openings between groups. Canopy cover within VSS 4-5-6 groups would vary from 40 percent to 70 percent. At the group level, basal areas would average 70 ft² per acre or greater in VSS 4, 5 and 6 groups. Stand density indices would be below 35 percent of SDI max over the majority of the area.

All yellow pines would be retained except where necessary for harvesting operations (e.g. in cable logging corridors). All snags greater than 12 inches diameter would be retained, 3 downed logs greater than 12 inches diameter and at least 8 ft. long, and 5-7 tons of woody debris greater than 3 inches in diameter would be retained per acre. Regeneration openings up to 2 acres with a maximum width of 200 feet may be created; however openings should rarely be greater than two acres and the average opening size is approximately one acre. Regeneration openings would comprise up to 20 percent of each stand. Three to five trees per acres would be retained in openings greater than one acre.

Ponderosa Pine Restoration within Northern Goshawk Post Fledging Nest Areas

Desired future conditions include mature to old age trees with high canopy cover. Canopy cover averages approximately 60% across VSS 4-5-6 tree groups. All snags greater than 12 inches diameter would be retained, 3 downed logs greater than 12 inches diameter and at least 8 ft. long, and 5-7 tons of woody debris greater than 3 inches in diameter would be retained per acre. No openings would be created and treatments would emphasize retention of large trees. Retain and promote large trees. Within the northern goshawk nest area, desired future conditions include non-uniform tree spacing and increased tree growth to progress VSS 4 to VSS 5 and 6.

Forest plan standards and guidelines for canopy cover will be assessed at the stand level to meet the Forest Plan (USDA FS 1987, as amended). Forest Plan standards for canopy cover apply to VSS 4, 5, and 6 within ponderosa pine. Canopy cover is averaged across the stand. Standards vary within and outside of northern goshawk PFAs and within goshawk nesting areas.

Ponderosa Pine within MSO Protected Activity Centers (PACs)

Desired future conditions for stands of ponderosa pine inside MSO PACs is to achieve old growth structural attributes as specified in the revised MSO Recovery Plan (USDI FWS 2012) and to reduce the risk of high intensity wildfire from burning up the PAC by reducing the fuels hazard. The desired conditions listed in the recovery plan call for a diversity of patch sizes with a minimum patch size of 2.5 acres, horizontal and vertical heterogeneity within patches, maintain or increase species diversity, create openings up to 2.5 acres in size, maintain canopy cover of 40 percent, and maintain 50 percent of basal area in trees greater than 16 inches DBH. Treatments would retain all trees greater than 18 inches dbh, woody debris larger than 12 inches in diameter, retain all snags, and all hard wood trees.

Forest Structure

Desired future conditions within the ponderosa pine cover types include: a more "open" forest structure that is sustainable, uneven-aged, and within the historic range of natural variability. Trees would be arranged primarily in "groups" of varying shape, size, and number of trees, with a mosaic pattern of individual and clustered trees interspersed among openings. The project area would exhibit an increase in age class diversity, decreased canopy cover, improved successional dynamics, increased and unsuppressed regeneration, increased old-growth forest, and increased vertical and horizontal heterogeneity.

Mixed Conifer

Dry Mixed Conifer Restoration

Desired future conditions within the conifer cover types include: a more "open" forest structure that is sustainable, uneven-aged, and within the historic range of natural variability. Trees would be arranged primarily in "groups" of varying shape, size, and number of trees, with a mosaic pattern of individual and clustered trees interspersed among openings. The project area would

maintain age class diversity, decrease canopy cover, improve successional dynamics, increase unsuppressed regeneration, increase old-growth forest, and maintain or increase vertical and horizontal heterogeneity.

Regeneration openings up to 2 acres with a maximum width of 200 feet may be created; however openings are rarely greater than two acres and the average opening size is approximately one acre. Three to five trees per acres would be retained in openings greater than one acre.

All yellow pines and mixed conifer trees with fire scars would be retained. All snags greater than 18 inches diameter would be retained, 5 down logs greater than 12 inches diameter and at least 8 ft. long, and 10-15 tons of woody debris greater than 3 inches in diameter would be retained per acre.

Dry Mixed Conifer within MSO Protected Activity Centers

Desired future conditions for stands of mixed conifer inside MSO PACs is to achieve old growth structural attributes as specified in the revised MSO Recovery Plan and to reduce the risk of high intensity wildfire from burning up the PAC by reducing the fuels hazard. The desired conditions listed in the recovery plan call for a diversity of patch sizes with a minimum patch size of 2.5 acres, horizontal and vertical heterogeneity within patches, maintain or increase species diversity, create openings up to 2.5 acres in size, maintain canopy cover of 60 percent, and maintain 50 percent of basal area in trees greater than 16 inches DBH. Treatments would retain trees greater than 18 inches dbh, yellow pines, mixed conifer trees with fire scars, snags greater than 18 inches, down logs greater than 12 inches mid-point diameter, and large hardwoods.

Wet Mixed Conifer within MSO Protected Activity Centers

Desired future conditions for wet mixed conifer is to maintain a sustainable uneven-age structure perpetuated by small scale natural disturbance events. Effects from a wildfire would be moderate with mixed severity burns. The percentage of area in early seral stages is well represented. Small openings allow for the establishment of early seral species, such as aspen, pine, and Douglas-fir across the forest type. Large hardwoods, oak and maple, are maintained and are successfully regenerating.

Dry Mixed Conifer MSO Recovery Habitat

Within MSO recovery habitat, desired conditions include treatments that mimic natural disturbance patterns by incorporating natural variation, such as irregular tree spacing and various patch sizes. Stand structure should be uneven-aged. Treatments would emphasize the retention of trees greater than 24 inches dbh, yellow pines, mixed conifer trees with fire scars, snags greater than 18 inches, down logs greater than 12 inches mid-point diameter, and large hardwoods.

Dry Mixed Conifer MSO Nest Roost Recovery Habitat

Within MSO recovery habitat, desired conditions include a minimum average basal area of 120 ft^2 per acre. Trees from 12-18 inches dbh would comprise thirty percent of stand basal area and an additional 30 percent of basal area would come from trees greater than 18 inches dbh. The desired conditions for nest roost recovery also call for a diversity of patch sizes with a minimum patch size of 2.5 acres, horizontal and vertical heterogeneity within patches, maintain or increase species diversity, create openings up to 2.5 acres in size, maintain canopy cover of 60 percent. Desired conditions include treatments that mimic natural disturbance patterns by incorporating natural variation, such as irregular tree spacing and various patch sizes. Stand structure should be uneven-aged. Treatments would not remove trees greater than 18 inches dbh, yellow pines,

mixed conifer trees with fire scars, snags greater than 18 inches, down logs greater than 12 inches mid-point diameter, and large hardwoods.

Aspen

Desired future conditions within the aspen cover type include: retention of aspen across in existing stands, increased regeneration, protection of regeneration from ungulate browsing, decreased conifer density and competition within aspen clones, and improved health, vigor, longevity, and sustainability of aspen clones.

Grasslands/Meadows

The desired condition for mountain grasslands and meadows is to be relatively free of conifer encroachment, and to maintain a healthy and vigorous herbaceous production that allows for periodic and regular fire return intervals, which would also prevent conifer encroachment.

Forest Health and Species Diversity

Desired future conditions across the project area include improved tree health and vigor, improved forest health, and a sustainable forest structure that is more resilient to insects and diseases.

Dwarf mistletoe is an element of the forest landscape. There is a varied level of mistletoe across the landscape, comparable with historic conditions such that it does not impede achieving and sustaining desired uneven-aged forest conditions. Desired stand dwarf mistletoe infection levels do not exceed 20% infection of the host species (trees per acre basis), or 25% of the area infected for any given tree species (Conklin and Fairweather 2010). Dwarf mistletoe infections are irregularly distributed among tree groups, such that effects are limited to the forest group and patch scale.

Desired future conditions for understory vegetation include increased diversity, productivity, and abundance of understory species.

Old Growth

Desired conditions for old growth are to allocate a minimum of 20 percent of the forested landscape for managing towards old-growth conditions. Desired conditions for all stands of ponderosa pine and mixed conifer which fall inside designated MSO PACs, and in northern goshawk nest areas is to achieve old growth structural attributes as specified in the Forest Plan.

Need for Change

Ponderosa Pine

In general across northern goshawk habitat, there is a need to decrease canopy cover and create a more variable and patchy tree distribution. There is a need to decrease the percent of the project area in "closed" canopy conditions within VSS 3, 4, 5, and 6 groups. There is also a need to create a more variable, patchy tree distribution across the project area. There is a need to decrease stand densities in the majority of the ponderosa pine and mixed conifer forest within the project area. There is a need to reduce tree densities across northern goshawk nest areas and create non-uniform tree spacing

Vegetative Structural Stage (VSS)

The desired VSS distribution for the northern goshawk according to the Forest Plan (USDA FS 1987, as amended), in comparison with existing conditions and the resultant gap, is displayed in Table 21. VSS guidelines apply only to pine stands located outside of MSO habitat. In order to obtain desired future conditions, there is a need to decrease the proportion of the ponderosa pine in young and mid-aged forest by approximately 43 percent. VSS 1 and 2 are severely lacking across the project area or occurs in small amounts. Thus, there is a need to create up to 20% openings across the forested ponderosa pine stands within the project area to increase and promote existing natural regeneration, thereby increasing VSS1 and VSS2. Additionally, there is a need to increase the proportion of the project area in mature to old forest by approximately 22 percent.

Currently approximately 100 percent of goshawk nest areas within the ponderosa pine are VSS 4. There is a need to manage nest stands to help move the nests stands to the desired VSS 5 and 6 classes.

Table 21: Desired Vegetative Structural Stage (VSS) distribution for the northern goshawk, according to the Forest Plan, for the Dry Lake Hills area

VSS DISTRIBUTION	VSS 1	VSS 2	VSS 3	VSS 4	VSS 5	VSS 6
DESIRED FUTURE CONDITIONS	10%	10%	20%	20%	20%	20%
EXISTING CONDITIONS: Ponderosa Pine	0	0	39	44	7	11
NEED FOR CHANGE	+10%	+10%	-19%	-24%	+13%	+9%

Dry Mixed Conifer

There is a need to reduce overall stand density in the majority of mixed conifer stands. There is a need to reduce the threat of high intensity wildfire in mixed conifer stands within the MSO PACs. There is a need to reduce fire hazard to "low" or "moderate" and to create conditions conducive to the reintroduction of low-intensity prescribed fire. There is a need to create a leave tree arrangement that would result in decreased inter-tree competition, increased tree health and vigor, reduced fire hazard, and increased size class diversity

There is a need to reduce canopy cover on the 76 percent of mixed conifer areas where canopy cover exceeds 60 percent. There is a need to reduce SDI in mixed conifer areas where SDI is greater than 35 percent of max SDI. Three is a need to reintroduce periodic low intensity fires.

Wet Mixed Conifer

There is a need to minimize the amount of high burn severity that would occur if the wet mixed conifer areas were to burn in a wildfire. There is a need to reduce the current fuel loading. There is a need to increase the percentage of early seral species the wet mixed conifer by creating openings across 10% of the area. There is a need to protect aspen and maple regeneration from ungulate browsing by jackstrawing or fencing.

Aspen

There is a need for increased regeneration, protection of regeneration from ungulate browsing, decreased conifer density and competition within aspen clones, and improved health, vigor, longevity, and sustainability of aspen clones. There is a need to remove conifer encroachment across 22 acres of identified aspen stands and within pockets of aspen that occur within ponderosa pine and mixed conifer stands. There is a need to protect aspen regeneration from ungulate browse by either jackstrawing or fencing.

Old Growth

There is a need to increase the amount of area allocated to be managed towards old-growth desired conditions in the ponderosa pine cover type forest in the Mormon Mountain area by a minimum of 332 acres. There is a need to designate and manage to develop old growth all stands within MSO PACs and goshawk nest stands that do not currently meet existing old growth conditions. Those stands would need to be managed to achieve old growth conditions.

Grasslands/Meadows

There is a need to restore identified mountain grasslands and meadows. There is a need to remove encroachment to the known historic extent and to restore frequent fire return interval.

Forest Health and Species Diversity

There is a need to decrease stand densities below critical thresholds for increased risk of bark beetle attack and mortality. There is a need to reduce fire hazard to "low" or "moderate" and to create conditions conducive to the reintroduction of low-intensity prescribed fire. There is a need to create a leave tree arrangement that would result in reduced fire hazard, decreased inter-tree competition, increased tree health and vigor, and increased size class diversity.

Table 22: Proposed Treatment Descriptions, Objectives and Acres

Treatment Type	Treatment Description/Objective	Dry Lake Hills			Mormon Mtn.		
		Alt. 2	Alt. 3	Alt. 4	Alt. 2	Alt. 3	Alt. 4
Aspen Treatment	A variety of different treatments would be used to promote and protect aspen health and regeneration, including the removal of post settlement conifers within 100 feet of aspen clones, prescribed fire, ripping, planting, fencing and/or cutting of aspen to stimulate root suckering.	22	22	2			
Burn Only	Burn only treatment would remove excessive fuel loading in areas that were previously burned by the Radio Fire.	270	270	67			

Electronic Site - Structure Protection	These sites are occupied by telecommunication facilities, and would be treated to provide a sufficient defensible space around these structures from a wildland fire. Individual trees that are determined to contribute to wildfire risk or pose a hazard to the electronic sites would be removed. The remainder of the sites would receive a thin from below to approximately 20 – 40 ft^2 basal area with the purpose of raising the crown base height and leaving the largest and most fire resistant trees.	6	6	6	12	12	12
Northern Goshawk Nest Fuels Reduction	Mechanical treatment designed to develop northern goshawk nest stand conditions consisting of a contiguous over-story of large trees. Forest Plan guidelines for canopy cover would be met, canopy cover would vary from 50 to 70%.	100	100	100			
Northern Goshawk Post Fledging Areas (PFA) Fuels Reduction	Uneven-age mechanical treatment designed to develop uneven-aged structure and a mosaic of openings and tree groups of varying sizes. Openings would occupy up to 20 percent of the treatment area. Tree groups would vary in shape, size, density, and number: generally from 0.05 – 0.7 acres in size with residual group basal areas of up to 30-90 ft^2 per acre and 2-40 trees per group.	359	359	286			
Grassland Restoration	Mechanical treatment to remove encroaching post-settlement conifers and restore the pre-settlement tree density and patterns.	60	60	53			

Mixed Conifer Fuels Reduction	These treatments areas include dry mixed conifer areas outside of MSO PACs, and northern goshawk PFAs and nest cores, but include MSO recovery habitat. Mechanical treatment designed to develop uneven-aged structure and a mosaic of openings and tree groups of varying sizes. Trees above 24" dbh would not be cut except if necessary for cable corridor locations. Openings would occupy up to 20 percent of the treatment area. Tree groups would vary in shape, size, density, and number: generally less than one acre in size with residual group basal areas of 30-90 ft^2 per acre and 2-50 trees per group.	1140	1158	542			
Mixed Conifer Fuels Reduction - Hand Thin	These treatment areas included areas where fuels reduction objectives can be met through hand thinning trees < 9" dbh or occur in areas where mechanical treatment would cause high levels of resource damage or would be cost prohibitive to treat mechanically.	132	85	0			
MSO Nest Fuels Reduction - Burn Only	Mechanical or manual treatment of MSO core areas and MSO nest/roost recovery habitat (aka target threshold) would occur in coordination with the US Fish and Wildlife Service. Residual basal area would be a minimum of 110 ft^2 in ponderosa pine, and 120 ft^2 in mixed conifer. Maintain a minimum of 40 percent canopy cover in pine/pine-oak and 60 percent in mixed conifer. Post-treatment, a minimum of 12 trees greater than 18" dbh per acre would be present; trees greater than 12-18" dbh would comprise over 30 percent of stands, per the MSO Recovery Plan guidelines (2012).	261	261	0	402	402	0

MSO Nest Fuels Reduction - Hand Thin	Manual treatment of MSO nest core areas would occur in coordination with the US Fish and Wildlife Service. Residual basal area would be a minimum 110 ft². Treatments would maintain a minimum of 60 percent canopy cover. Up to 20% of unit would be deferred around known nest and roost sites and potential nest and roost sites.	122	122	122			
MSO Nest Roost Recovery – Burn Only	Burn only treatment would reduce dead and down fuels, and reduce the number stems in the small to medium size classes and raise canopy base heights.	37	37	0			
MSO Nest Roost Recovery	Treatment of MSO nest/roost recovery habitat (previously known as target threshold) would occur in coordination with the US Fish and Wildlife Service. Treatments would be designed to move stand conditions towards desired Nest Roost Recovery conditions of 120 ft² of basal area with 30% of BA occurring in 12-18" dbh size class and 30% of BA occurring in >18" dbh trees. Treatments would also retain or improve species diversity and diversity of tree sizes and spacing. Treatments would not lower stands that currently meet conditions to below desired conditions.	72	72	0	22	22	22
MSO PAC Fuels Reduction	Mechanical treatment to create a diversity of patch sizes with minimum patch size of 2.5 acres. Provide for 10-30 percent openings across treatment areas from 0.1 – 2.5 acres in size. Maintain a minimum of 40 percent canopy cover in pine/pine-oak and 60 percent in mixed conifer. Post-treatment, trees greater than 16" dbh would contribute at least 50 percent of the stand basal area per MSO Recovery Plan guidelines (2012). Trees above 18" dbh would not be cut except if necessary for cable corridor locations.	1167	1195	568	1592	1592	1509

MSO PAC Fuels Reduction - Hand Thin	This treatment includes steep areas which have low density and dominated by smaller trees or are in areas not conducive to cable yarding operations. Where feasible, treatments would have similar objectives to those described in the MSO PAC Fuels Reduction treatment above; with the limitation that cutting would be limited to trees up to 9" dbh due to the constraints of hand thinning operations. Otherwise treatments would be thin from below up to 9" dbh to reduce density and fuel ladders	202	202	228			
MSO PAC Fuels Reduction – Wet Mixed Conifer	This treatment would create small openings by hand in and around Aspen patches to regenerate aspen and maintain early seral species throughout this cover type. Dead and down material would be piled for burning to reduce the heavy fuel loading and allow for lower-intensity prescribed burning. Trees over 18" dbh would not be cut.				180	180	0
No Additional Treatment	This area is being treated as part of the Orion Timber Sale which has already been analyzed and authorized under the Jack Smith Schultz Fuels Reduction and Forest Health Restoration Project Decision Notice/Finding of No Significant Impact (2008).	836	836	836			
No Treatment	These acres include non-treatable areas, including rock faces and boulder fields.	769	769	3274	0	0	631

Ponderosa Pine Fuels Reduction	These treatments areas are outside of MSO PACs and northern goshawk PFAs and nest cores. Mechanical treatment designed to develop uneven-aged structure and a mosaic of openings and tree groups of varying sizes. Openings would occupy 20 percent of the treatment area. Tree groups would vary in shape, size, density, and number: generally from 0.05 – 0.7 acres in size with residual group basal areas of 20-80 ft² per acre and 2-40 trees per group.	1865	1865	1400	766	766	766
Ponderosa Pine Fuels Reduction - Hand Thin	This treatment includes steep areas that have low tree density and/or are dominated by smaller diameter trees where the purpose and need can be met through hand felling treatments up to 9" dbh. Where practical and feasible, treatments would be designed to develop uneven-aged structure and a mosaic of interspaces and tree groups of varying sizes similar to the treatment described above.	150	150	86			

The following table (Table 23) shows the proposed treatments and whether they fit under the umbrella of restoration, or if they're more aimed toward fire-risk reduction. In some cases, the fire-risk reduction treatments would result in denser forest conditions than a restoration approach; this is tied to fire regimes, wildlife habitat limitations, and also the influence of the wildland-urban interface and the project's purpose and need.

The fire regime for dry mixed conifer is very similar to that of ponderosa pine, the fire regimes of wet mixed conifer involves less frequent, higher-severity fires than what is desirable for protection of soil resources and the adjacent urban interface. Thus, for those areas, the proposed treatment approach is more geared toward fire-risk reduction than true restoration.

A large portion of the project area falls within MSO habitat; management of those areas is guided by the Recovery Plan, and as such, the desired conditions may generally be denser (i.e. higher canopy cover, higher basal area) than what may have been present in mixed conifer historically. Therefore the proposed treatments would achieve the purpose and need of reducing the risk of high-severity wildfire even though they might not meet full restoration conditions.

The mixed conifer treatments proposed under the action alternatives for FWPP could very well be similar to historical conditions in each of those locations; however due to the reasons cited above, restoration is only cited as such in the treatments below when that approach also met the purpose and need for the project.

Table 23: Proposed Treatments and their focus (restoration versus fire risk reduction)

Treatment:	Focus:	Effect of focus:
Aspen Treatment	Restoration	Restoring aspen stands achieves fire risk reduction and desired condition.
Burn Only	Fire Risk Reduction	Prescribed burning would reduce fire risk and moves towards desired condition but would not necessarily achieve restoration objectives.
Electronic Site - Structure Protection	Fire Risk Reduction	These are highly developed and managed sites and restoration is not desirable or practical.
Northern Goshawk Nest Fuels Reduction	Restoration	Treatment would be designed to create habitat for northern goshawk nests, Tree density would be similar but denser than historic conditions, but tree size distribution and spatial arrangement would not follow historic patterns.
Northern Goshawk Post Fledging Areas (PFA) Fuels Reduction	Restoration	Treatment would move stands towards sustainable uneven-aged conditions and spatial arrangements which would be similar and within the natural range of variability for this forest type. Treatment would also meet fire risk reduction objectives and desired condition.
Grassland Restoration	Restoration	Restoration of historic grassland extent would also meet fuels reduction objectives and desired conditions.
Mixed Conifer Fuels Reduction	Restoration	Treatment would move stands towards sustainable uneven-aged conditions and spatial arrangements which would be similar to and within the natural range of variability for this forest type. Treatment would also meet fire risk reduction objectives.
Mixed Conifer Fuels Reduction - Hand Thin	Fire Risk Reduction	Treatment would reduce fire risk and would move stands towards but not meet desired conditions. Tree densities would be higher than historic levels and spatial patterns would not mimic historic patterns.
MSO Nest Fuels Reduction - Burn Only	Fire Risk Reduction	Prescribed burning would reduce fire risk but would not necessarily achieve restoration objectives.
MSO Nest Fuels Reduction -	Fire Risk Reduction	Treatment would reduce fire risk. Tree densities would be higher than historic

Treatment:	Focus:	Effect of focus:
Hand Thin		levels and spatial patterns would not mimic historic patterns.
MSO Nest Roost Recovery – Burn Only	Fire Risk Reduction	Prescribed burning would reduce fire risk but would not necessarily achieve restoration objectives.
MSO Nest Roost Recovery	Fire Risk Reduction	Treatment would reduce fire risk. Tree densities would be higher than historic levels and spatial patterns would not mimic historic patterns.
MSO PAC Fuels Reduction	Fire Risk Reduction	Treatment would move stands towards uneven-aged conditions and spatial arrangements. Conditions would be much denser than historical conditions. Treatment would reduce fire risk.
MSO PAC Fuels Reduction - Hand Thin	Fire Risk Reduction	Treatment would reduce fire risk and would move stands towards but not meet desired conditions. Tree densities would be higher than historic levels and spatial patterns would not mimic historic patterns.
MSO PAC Fuels Reduction – Wet Mixed Conifer	Fire Risk Reduction	Treatments would regenerate patches of aspen which would reduce fire risk and achieve limited restoration objectives.
Ponderosa Pine Fuels Reduction	Restoration	Treatment would move stands towards sustainable uneven-aged conditions and spatial arrangements which would be similar to and within the natural range of variability for this forest type. Treatment would meet fire risk reduction objectives and desired conditions.
Ponderosa Pine Fuels Reduction - Hand Thin	Fire Risk Reduction	Treatment would reduce fire risk and would move stands towards but not meet desired conditions. Tree densities would be higher than historic levels and spatial patterns would not mimic historic patterns.

Environmental Consequences

Environmental consequences of each alternative on the different vegetation cover types, old growth, and forest health are discussed first, followed by a general discussion of cumulative effects for all action alternatives and the No Action Alternative.

Ponderosa Pine – Dry Lake Hills

Ponderosa Pine Fuels Reduction – 1865 acres

Ponderosa Pine Fuels Reduction - Hand Thin – 150 acres
Goshawk PFA Fuels Reduction – 178 acres
Goshawk Nest Fuels Reduction – 45 acres
MSO PAC Fuels Reduction – 379 acres
MSO PAC Fuels Reduction - Hand Thin —94 acres
MSO Nest Fuels Reduction - Burn Only –97 acres
Burn Only – 132 acres

Alternative 1 – No Action

Direct & Indirect Effects

Under the no action alternative, forested areas would remain in an even age condition; stands would continue to be dominated by VSS 3 and 4 size classes. Mature and old forest conditions would continue development at a slow pace and would be at risk of increased rates of mortality (Ritchie et al. 2008, Davis et al. 2007).

Over 40 years, canopy cover would increase, basal areas would increase, and trees per acres would decrease. Closed crown canopies result in decreased sunlight to the forest floor, decreased understory productivity and diversity, increased inter-tree competition, decreased tree health, growth and vigor, increased insect and disease-related mortality especially in older age classes, decreased understory productivity and diversity, and decreased horizontal heterogeneity. Number of medium and large sized snags would increase overtime due to competition-induced mortality.

Table 28 and Table 29 show the modeling results of the action alternatives and the no action alternative grown out 20 and 40 years from the time of treatment. Under the no action, the LOPFA and PFA stands would still have an even-aged stand structure. The nest stand would still be a VSS4. In this alternative, stand conditions would continue to have high density, which contributes to competition induced mortality occurring and increases the bark beetle hazard. It also reduces the likelihood of development of mid-aged trees to large trees with old growth characteristics. Stands would be dominated by VSS 4, 5 and 6 size classes and would still be an even-age stand.

While it is not displayed in the tables below, the stand exam data shows that there is a severe dwarf mistletoe infection in the MSO PAC Fuels Reduction treatment areas. This has caused the No Action density numbers to decline as opposed to going up as expected. The severe level of dwarf mistletoe infection would decreases the ability of the stand to maintain high levels of canopy cover and would reduce the rate of tree growth, thus limiting the ability of the stand to maintain large trees and high canopy cover.

Alternatives 2, 3, & 4

General Direct & Indirect Effects

Effects common to all proposed actions:
All of the treatments described below would have a prescribed broadcast burn applied after vegetation treatments are completed. Burning of dead and down fuels would release nutrients and create small patches of mineral soil, which would facilitate future regeneration. According to the fire and fuels effects results in the FVS modeling, after vegetation treatment, prescribed burns would cause approximately 3% reduction in stand density of max SDI. The mortality

caused by prescribed fire is random and unpredictable in terms of identifying which trees would be killed by the burn. However overall mortality is greatly reduced compared to a prescribed burn applied to the no action alternative.

Ponderosa Pine Fuels Reduction – **Alts 2 & 3: 1865 acres; Alt 4: 1400 acres**
Ponderosa Pine Fuels Reduction - Hand Thin – **Alts 2 & 3:150 acres; Alt 4: 86 acres**
These two treatments affect the majority of the pine habitat outside of the northern goshawk PFAs and MSO habitat areas. This area would be treated following the Forest Plan standards and guidelines for managing northern goshawk habitat outside of PFAs. Stands would also have an initial entry prescribed burn several years after completion of vegetation treatments. Out of these pine stands, 277 acres are classified as pine-oak stands and are considered recovery habitat for the MSO. For this analysis, they will be lumped with the non-recovery pine; however treatments specific to the pine-oak stands would meet the guidelines in the revised MSO recovery plan.

Goshawk PFA Fuels Reduction – **Alts 2 &3: 178 acres; Alt 4: 105 acres**
Two PFAs occur within the Dry Lake Hills. The Orion PFA outside of the nest area is all ponderosa pine; the Schultz PFA is a mix of ponderosa pine and mixed conifer. Alternatives 2 and 3 affect both of those PFAs outside of the identified nest areas, while Alternative 4 would affect only the Schultz PFA. The Orion PFA would not be treated in Alternative 4. The areas would be treated following the Forest Plan standards and guidelines for managing northern goshawk PFAs. Stands would also have an initial entry prescribed burn several years after completion of vegetation treatments. See Direct and Indirect Effects to Goshawk Habitat discussion below for more information on anticipated effects.

Goshawk Nest Fuels Reduction – **Alts 2, 3, &4: 45 acres**
Two identified goshawk nest areas occur in the Dry Lake Hills. Alternatives 2, 3 and 4 would mechanically treat only the Schultz PFA nest area (the Orion nest is located within the Orion MSO PAC nest and would be treated in the proposed burn-only for MSO nest cores). This area would be treated following the Forest Plan standards and guidelines for managing northern goshawk PFA nest areas. The Schultz PFA nest area is 100 acres; of which only 45 acres is being treated by this proposed treatment (the remaining 54 of the goshawk nest acres are classified as mixed conifer recovery habitat for MSO). Treatments in both the goshawk nest area and MSO recovery habitat would retain the majority of trees over 18 inches dbh and would not cut trees over 24 inches dbh. Stands would also have an initial entry prescribed burn several years after completion of vegetation treatments. See Direct and Indirect Effects to Goshawk Habitat discussion below for more information on anticipated effects.

MSO PAC Fuels Reduction – **Alts 2 & 3: 379 acres; Alt 4: 230 acres**
MSO PAC Fuels Reduction - Hand Thin —**Alts 2 &3: 94 acres; Alt 4: 107 acres**
These treatments would apply to ponderosa pine stands that are located within the four MSO PACs located within the Dry Lake Hills. Under Alternatives 2 and 3, up to 379 acres would be mechanically treated and an additional 94 acres would be treated by hand. Alternative 4 would treat fewer acres mechanically, but more by hand: 230 acres and 107 acres, respectively. Treatments would maintain a minimum of 40 percent canopy cover and openings would be created from 0.1 to 2.5 acres in size in up to 10 percent of the treatment acres. Treatments would be designed to maintain or create horizontal and vertical patch heterogeneity. Tree species diversity would be maintained with an emphasis on protecting large oaks. Trees over 18 inches dbh would not be cut, except for on 44 acres of proposed cable yarding in Alternative 2, where it would be necessary to cut trees larger than 18 inches dbh for the purpose of creating the cable yarding corridors. No snags would be targeted for removal except for in the 44 acres of cable yarding in Alternative 2 and the 16 acres of helicopter in Alternative 3, in which all the snags are

assumed to be cut due to safety requirements. In Alternative 3, there would be 28 acres treated using specialized steep slope harvesters. While the steep slope harvesting machines are similar to ground based equipment, they are not as maneuverable on steep slopes as they are on flatter ground. The limited maneuverability may require the removal of snags, oaks, or trees over 18 inches dbh only when necessary for the machine to operate safely. However the removal of these forest components is anticipated to be negligible and would not impact the ability of those areas to meet desired conditions. Hand thinning treatments would generally only treat up to 9 inches dbh. Stands would also have pile burning and an initial entry prescribed burning several years after completion of vegetation treatments.

MSO Nest Fuels Reduction - Burn Only –**Alts 2 & 3: 97 acres; Alt 4: 0 acres**
Burn Only – **Alts 2 & 3: 132 acres; Alt 4: 0 acres**
The burn only treatments would occur in MSO nest cores or in ponderosa stands where thinning of vegetation would not be need to achieve fuels reduction objectives. Burning of MSO nest cores would occur outside of the breeding season. The analysis of the burn only treatment is not included in the tables below as there is no stand exam data collected in those areas. The analysis of the burn only area will be included in the narrative below.

Direct & Indirect Effects to Goshawk Habitat Common to Alternatives 2 & 3

*Ponderosa Pine Fuels Reduction – **1865 acres***
*Goshawk PFA Fuels Reduction – **178 acres***
*Goshawk Nest Fuels Reduction – **45 acres***

All three levels of analysis show that the goshawk habitat area is dominated by VSS 3 and 4 structural stages. VSS 1, 2, and 5 are lacking. At the point level LOPFA and PFA appear to have adequate representation of VSS 6, however at the stand level, LOPFA areas are lacking in VSS 6 while PFAs are over represented in VSS 6. Then at the large scale, it show that VSS 1, 2, 5, and 6 are lacking across the Ponderosa pine vegetation. There is a need to create openings to introduce new VSS 1 and 2 areas. There is also a need to thin the VSS 3 and 4 stands to promote the growth of larger trees and to reduce large tree mortality (Ritchie et al. 2008).

The treatments proposed under Alternatives 2 and 3 would create openings to begin the process of creating an uneven-aged stand structure with vertical diversity (except in the nest stands) by reducing the amount of VSS 3 and 4 and increasing the amount of VSS 1 and 2. The remaining areas outside of the regeneration openings would be thinned into groups creating horizontal diversity. Thinning would also have the effect of promoting the growth of large trees, reducing the potential large tree mortality caused by inter-tree competition, and increasing the development of VSS 5 and 6 size classes in the near future (Ritchie et al. 2008, Davis et al. 2007). The proposed initial entry burn would happen approximately two years after vegetation treatment. The post treatment conditions listed in Table 27 are immediately after vegetation treatment and before the initial prescribed burn.

Current habitat variables such as basal area, canopy cover, and trees per acre, SDI, and snags are similar between LOPFA and PFA treatment areas, with the nest areas having a slightly higher BA, CC, and SDI, but fewer TPA and large snags. Canopy cover is measured across the stand and includes openings within the stand, CC values range from 69 to 72 percent. Basal area ranges from 132 to 146 ft^2 and TPA (trees per acre) range from 256 to 391 trees. The percent of max SDI is at the high end of High density and low end of Extreme density.

Table 27 includes post-treatment conditions at the stand level for the LOPFA, PFA, and nest areas, and shows some changes in VSS classes from Alternatives 2 and 3. For example, within the LOPFA areas, the percent of VSS 5 increases from 8 percent before treatment to 22 percent after treatment, while the percent of VSS 3 decreases from 32 percent to 1 percent. This is the result thinning of stands that are dominated by VSS 3 or VSS 4 sized trees (5-18 inches dbh), but which also have a fair amount of VSS5 size trees (18 – 24 inches dbh). In these stands, many VSS 3 and 4 trees are being removed while almost no VSS 5 trees are removed. As a result, the percent of basal area from VSS 3 trees no longer dominates the stand, and the basal area from VSS 5 trees is greater than the basal area of other VSS classes. Again in table 16, under the PFA, there is an increase in VSS 5 and 6 and decrease in VSS 3 and 4. Reasons for these changes are that these stands are dominated by a mix of VSS3 and VSS4 (5 – 18 inch dbh) trees. Typically the VSS 5 and 6 trees are dominate and co-dominate trees while the VSS 3 and 4 trees are co-dominate, intermediate, and suppressed trees.

In order to move toward the desired conditions for increasing the amount of VSS 5 trees and openings, it is necessary to remove those in greatest abundance, which includes VSS 3 and 4 trees. As a result, a large number of stands in the PFA would shift from VSS 3 and 4 to VSS 5 and 6. That is not to say all VSS 3 sized trees would be cut; rather, a group comprised of dominate VSS 3 trees would still be a VSS 3 group after thinning. However at the stand level the VSS class would still be classified as a VSS 5 or 6. Over time, after this treatment, the openings to create VSS 1 groups would become VSS 2 and then VSS 3 tree groups, and in future treatments, new openings would be created in those areas with an overabundance of VSS5 and 6 tree groups.

Converting the even-age stands to uneven-aged stands within this project area would take several treatments, the implementation of which would span over many decades. Post-treatment values of SDI for LOPFA Area is low density, while the PFA and nest stands would have an SDI value at the low end of moderate density.

One of the main treatment differences between Alternatives 2 and 3 is the harvest methods. In Alternative 2 there would be 252 acres of cable thinning (out of 1865 total acres) in LOPFA and 60 acres (out of 178 total acres) in PFA, and in Alternative 3 there would be helicopter harvesting in 242 acres (out of 1865 acres) of LOPFA and 39 acres (out of 178 acres) of PFA. Both of these harvest methods require the falling of all snags for operational safety.

In Alternative 3 there would be 21 acres of steep slopes in the Goshawk PFA and 10 acres in Ponderosa Pine Fuels Reduction treated using specialized steep slope harvesting machines. While the steep slope harvesting machines are similar to ground based equipment, they are not as maneuverable on steep slopes as they are on flatter ground. The limited maneuverability may require the removal of snags, oaks, or trees over 18 inches dbh only when necessary for the machine to operate safely. However the removal of these forest components is anticipated to be negligible and would not impact the ability of those areas to meet desired conditions. Unlike cable or helicopter harvest methods, ground-based thinning operations do not require the falling of snags for safety reasons due to the enclosed cabs of the machines protecting the operators. When the cable treatments and helicopter treatments are averaged in with all the ground based treatment, there is only a very slight reduction in overall snag density across all those treatment acres.

Table 28 and Table 29 show the modeling results of the action alternatives and the no action alternative grown out 20 and 40 years from the time of treatment. In 20 years, areas treated under Alternatives 2 and 3 would have greater increase in the percent of VSS 1, 5, and 6 tree groups

versus the No Action, thus moving conditions toward desired conditions for vegetation structural stages. Openings created in the LOPFA and PFA treatments stands would have regenerated moving those stands towards the desired condition of uneven aged stand structure. The more open stand structure would increase overall tree growth among the remaining trees by reducing inter-tree competition and increasing the availability of moisture, nutrients, and sunlight. The treated stand in the goshawk nest treatments would have moved towards desired VSS by moving VSS 3 and 4 trees into a VSS5 classification more rapidly. The SDI values for the treated stands would still be in the Low to Moderate density ranges, whereas in the no action the density would be in the Extreme range. The average canopy cover for the nest stand would be lowered to 53% which is lower than the recommended 60% for Goshawk nest stands. This is because the entire stand is not entirely made up of VSS 5 and 6 tree groups. There are tree groups of VSS 1, 3, and 4 which will be managed at a lower canopy cover to allow for those tree groups to more quickly grow into the desired VSS 5 and 6 size class. After 20 years there is no discernable difference in the number of snags between Alternatives 2 and 3.

In 40 years the majority of the LOPFA and PFA stand would be in the VSS 5 and 6 classifications. The openings created during treatment implementation would now be fully occupied by regeneration and moving into the VSS 3 classification. After 40 years the Goshawk nest stands would be comprised of mostly VSS 5 and 6 tree groups and canopy cover would be at 61%.

*Ponderosa Pine Fuels Reduction - Hand Thin – **150 acres***
There would be 150 acres of hand thinning in ponderosa pine in goshawk habitat. Data for this treatment is not displayed in the tables below as there was no stand exam data available from the proposed treatment areas to input into the modeling effort. Field visits to these areas determined that desired could be met or nearly met by using hand thinning methods. Compared to the other pine treatment areas, the hand thinning treatment areas are either less dense and or have smaller average size trees. Most of the hand thinning areas are located on steep rocky south facing slopes with poorer site conditions. These stands with poor site conditions are often the first to be attacked by bark beetles in time of drought (North, 2012). The dominate VSS class is VSS 3, BA range from 60-120 ft² BA. Treatments would only thin trees up to 9 inches DBH. Where practical and feasible leave trees would be arranged in groups and clumps, small openings would be created for regeneration. Tree per acre would be reduced up to 75 percent, and basal area would be reduced up to 35 percent. The thinning would have the effect of reducing the bark beetle hazard through reduced competition stress (Hayes et al. 2009).

Direct & Indirect Effects to Goshawk Habitat – Alternative 4

*Ponderosa Pine Fuels Reduction – **1486 acres***
*Ponderosa Pine Fuels Reduction – Hand Thin – **86 acres***
*Goshawk PFA Fuels Reduction – **105 acres***
*Goshawk Nest Fuels Reduction – **45 acres***

In Alternative 4, fewer acres would be treated in the Ponderosa Pine Fuels Reduction and Goshawk PFA Fuels Reduction. There would be no treatment on steep slopes which would require cable yarding, helicopter, or specialized steep slope equipment. The treatment intensity in treated areas would remain the same as the other alternatives. The current conditions and post-treatment conditions are mostly similar in the LOPFA and PFA treatments between Alternative 4 and Alternatives 2 and 3. Alternative 4 post-treatment BA in LOPFA would be slightly lower and have higher number of TPA than Alternatives 2 and 3. Alternative 4 would only have 10

percent in VSS 6 compared to 27 percent for Alternative 2 and 3. This is because many of the areas that would become VSS 6 in Alternatives 2 and 3 would not be treated under Alternative 4. Many of the areas that would be treated under Alternative 4 do not have the large tree component necessary to create VSS 6. In the PFA, Alternative 4 would have a higher number of residual snags and large trees immediately post-treatment compared to Alternatives 2 and 3 due to the subset of acres currently contain a higher average number of snags and large trees. The PFAs would have no VSS 4, and a greater amount of VSS 5 and 6 compared to Alternatives 2 and 3. Goshawk nest treatments are the same in all the action alternatives.

Direct & Indirect Effects to MSO Habitat common to Alternatives 2 and 3

*MSO PAC Fuels Reduction – **379 acres***

The effect of treatment on MSO PAC Fuels Reduction areas reduces the BA from 130 to 106 ft² for Alternative 2 and to 108 ft² for Alternative 3. Under both Alternatives, canopy cover is reduced from 69 to 64, trees per acre are reduced from 92 to 46, and percent max SDI is reduced from 43 percent (high density) to 32 percent (moderate density). One of the differences between the alternatives is harvest methods. In Alternative 2 there would be 44 acres (out of 379) treated by cable yarding, which would require the cutting of all snags and removal of all trees (including those over 18 inches dbh) within the cable corridors. In Alternative 3, there would be 16 acres of helicopter logging within MSO PACs, which would require the removal of all snags for operational safety. After treatment there would be slightly less large snags per acre under Alternative 2 compared to Alternative 3: 5 snags per acre versus 5.5. Due to the treatment area having a relatively high number of trees greater than 18 inches dbh that would not be cut, the post-treatment stand conditions would continue to be relatively dense. The percent max SDI would continue to be in the extreme range. Competition induced mortality would continue to occur, the bark beetle hazard would be high and competition induced stress may cause the trees in this treatment area to be less resistant to insects and diseases.

In 20 years, BA, canopy cover, SDI, are all lower than the No Action Alternative. The number of large snags is about the same as current conditions, and there are slightly more large trees in Alternatives 2 and 3 than in the No Action due to increased growth rates from educed competition, which would also cause those large trees to be more resistant to mortality from competition, drought, insects and disease.

In 40 years, BA, canopy cover, and SDI are all still slightly lower than the No Action Alternative; however the number of snags and large trees are about the same. The treatment has the effect of reducing long-term mistletoe infection rating, thus improving the health and resiliency of the stands several decades after treatment.

*MSO PAC Fuels Reduction - Hand Thin —**94 acres***

Data for this treatment is not displayed as there was no stand exam data available from the proposed treatment areas. Field visits to these areas determined that desired conditions could be met or nearly met by using hand thinning methods. Compared to the other pine treatment areas, the hand thinning treatment areas are either less dense and or have smaller average size trees. Most of the hand thinning areas are located on steep rocky south facing slopes with poorer site conditions. These stands with poor site conditions are often the first to be attacked by bark beetles in time of drought. The dominate VSS class is VSS 3, BA range from 60-120 ft². Treatments would only thin trees up to 9 inches dbh. Where practical and feasible leave trees would be arranged in groups and clumps, small openings would be created for regeneration. Tree per acre would be reduced up to 75 percent, and basal area would be reduced up to 35 percent or

approximately 50 ft² BA (40 percent canopy cover). The thinning would have the effect of reducing the bark beetle hazard through reduced competition stress (Hayes et al. 2009).

*MSO Nest Fuels Reduction - Burn Only –**97 acres***

This treatment is located within the MSO nest cores. Prescribed burns would be conducted with low intensity with the purpose of reducing dead and down fuel loading, creating some mortality of smaller trees in the denser patches and raising canopy base heights. Prescribed burning would create a short term spike of smaller sized snags. Small opening may be created where the prescribed burn created pockets of mortality. The small openings would allow for trees to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics. Any small openings created would also have the effect of increasing understory production and diversity.

Direct & Indirect Effects of MSO Habitat – Alternative 4

*MSO PAC Fuels Reduction – **230 acres***

The 230 acres treated in this alternative is a smaller sub-set of the 379 acres in Alternatives 2 and 3. This alternative does not utilize any steep slope harvesting methods. The post-treatment BA and canopy cover on these acres would be lower to Alternatives 2 and 3 and this subset would also have a higher number of TPA and fewer large trees and snags. The post-treatment numbers show these acres would have a lower BA, canopy cover, and percent max SDI than the No Action Alternative. In 20 years after treatment, the models still show these acres would have a lower BA, canopy cover, and percent of max SDI compared to Alternatives 2 and 3. However, 40 years after treatment BA, canopy cover, percent max SDI and number of large trees would be very similar to Alternatives 2 and 3. This is due to the more open conditions allowing for medium size trees to grow into larger trees at a faster rate than the denser Alternative 2 and 3 conditions. Also the areas that would be treated under this alternative have a lower overall dwarf mistletoe infection level.

*MSO PAC Fuels Reduction - Hand Thin —**107 acres***

The effects of this treatment on these 107 acres would be the same described for the 97 acres of MSO PAC Fuels Reduction – Hand Thin for Alternatives 2 and 3.

Tables 24 through 29 include the Dry Lake Hills treatment analysis for goshawk habitat and ponderosa pine fuels reduction MSO habitat fuels reduction treatments. These series of tables show the habitat values for current conditions, post treatment conditions, and values projected out 20 years and 40 years. Values for VSS 1 & 2 have been combined into a single column.

Table 24: Small scale analysis of current conditions using data analyzed at the plot level and broken out into nest, PFA, and LOPFA areas. Average values calculated at the point level using individual stand exam plot data. Dry Lake Hills, FWPP.

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	VSS 1/2 %	VSS 3 %	VSS 4 %	VSS 5 %	VSS 6 %
LOPFA Areas	2015	115	66	261	43	4.4	2	12	10%	27%	29%	14%	20%
PFA Areas	178	137	70	321	50	3.9	1.5	12	8%	44%	19%	11%	18%
Nest Areas	45	139	71	259	55	3.2	.2	12	0%	25%	50%	13%	13%

Table 25: Mid-scale analysis of current stand condition using data analyzed at the stand level and broken out into nest, PFA and LOPFA areas. Average values calculated by stand broken out by LOPFA, PFA, Nest areas, MSO PAC treatments and MSO PAC Nest Burn Only treatments. Dry Lake Hills, FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	VSS 1/2 %	VSS 3 %	VSS 4 %	VSS 5 %	VSS 6 %
LOPFA Areas													
Alt 1, 2, & 3	2015	132	69	314	54%	2.1	1.2	14	0%	32%	53%	8%	7%
Alt 4	1486	134	70	391	57	1.9	1	11	0%	35%	55%	10%	0%
PFA Areas													
Alt 1, 2, & 3	178	138	70	307	54%	4.2	1.4	18	0%	51%	25%	0%	24%
Alt 4	105	137	70	355	54	5.4	1.8	21	0%	22%	39%	0%	39%
Goshawk Nest													
Alts 1, 2, 3, & 4	45	146	72	256	59%	4	.3	14	0%	0%	100%	0%	0%
MSO PAC treatments													
Alts 1, 2 & 3	379	130	69	92	43	10.1	5.5	22					
Alt 4	230	130	69	285	51	3.4	2.4	13					
MSO PAC Nest – Burn Only													
Alts 1, 2, 3, & 4	97	55	47	73	18	2.7	1.7	8					

Table 26: Large scale analysis of current conditions across all goshawk areas treated within the Dry Lake Hills Area. Stand values averaged across all ponderosa pine stands within the northern goshawk habitat. Dry Lake Hills, FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	VSS 1/2 %	VSS 3 %	VSS 4 %	VSS 5 %	VSS 6 %
All Goshawk Treated Acres	2238	133	69	312	54	2.3	1.2	14	0%	34%	51%	6%	9%

Table 27: Stand values of post vegetation treatment conditions (2013) for LOPFA, PFA, and Nest areas. Dry Lake Hills, FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	VSS 1/2 %	VSS 3 %	VSS 4 %	VSS 5 %	VSS 6 %
LOPFA Areas													
Alt 2	1865	48	43	138	19%	1.7	1.0	8	20%	1%	30%	22%	27%
Alt 3	1865	47	43	134	19%	1.7	1.1	8	20%	1%	30%	22%	27%
Alt 4	1486	43	41	177	19%	1.8	1	7	20%	2%	41%	27%	10%
PFA Areas													
Alt 2	178	73	54	99	26%	2.8	1.0	11	20%	0%	25%	11%	44%
Alt 3	178	69	52	98	25%	3.3	1.1	11	20%	0%	20%	11%	49%
Alt 4	105	74	54	106	26%	5.2	1.8	14	20%	0%	0%	18%	62%
Nest Areas													
Alts 2, 3, & 4	45	71	53	71	26%	3.9	.3	11	0%	0%	100%	0%	0%
MSO PAC treatments													
Alts 2	379	106	64	46	32%	8.9	5.0	23					
Alts 3	379	108	64	46	32%	10.1	5.5	24					
Alt 4	230	78	56	71	26%	3.5	2.4	13					
MSO PAC Nest – Burn Only*													
Alts 2 & 3	97	43	40	35	13%	10.5	2.2	8					

*Burn only treatments are modeled in 2016

Table 28: Average stand values of the no action and action alternatives projected 20 years out (2033). Dry Lake Hills, FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	VSS 1/2 %	VSS 3 %	VSS 4 %	VSS 5 %	VSS 6 %
LOPFA Areas													
Alt 1	2015	153	73	283	59%	4.2	1.4	23	0%	2%	67%	24%	7%
Alt 2	1865	54	46	105	21%	2.2	1.2	10	20%	0%	3%	43%	33%
Alt 3	1865	53	46	104	21%	2.3	1.2	10	20%	0%	3%	43%	34%
Alt 4	1486	46	43	128	19%	2.2	1	9	20%	0%	4%	58%	18%
PFA Areas													
Alt 1	178	152	73	271	55%	8.7	2.2	21	0%	9%	42%	49%	0%
Alt 2	178	67	52	97	25%	1.8	1.0	13	20%	0%	25%	0%	55%
Alt 3	178	66	52	96	24%	1.8	1.0	13	20%	0%	18%	7%	55%
Alt 4	105	81	57	87	27%	4.5	2.1	16	20%	0%	0%	0%	80%
Nest Areas													
Alt 1	45	164	74	210	62%	7.9	1	23	0%	0%	100%	0%	0%
Alts 2, 3, & 4	45	82	58	115	32%	4.4	1.2	24	0%	0%	0%	100%	0%
MSO PAC treatments													
Alt 1	379	118	66	71	38%	11.1	5.5	21					
Alts 2	379	97	61	80	32%	8.3	5.4	23					
Alt 3	379	98	61	80	33%	8.7	5.7	23					
Alt 4	230	81	57	156	30%	6.3	2.6	14					
MSO PAC Nest –Burn Only													
Alts 1 & 4	97	59	49	57	18%	4.6	2.4	13					
Alts 2 & 3	97	43	41	28	12%	7.6	2.6	10					

Table 29: Average stand values of the no action and action alternatives projected 40 years out (2053). Dry Lake Hills, FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	VSS 1/2 %	VSS 3 %	VSS 4 %	VSS 5 %	VSS 6 %
LOPFA Areas													
Alt 1	2015	165	75	253	60%	4.2	2	29	0%	0%	50%	38%	12%
Alt 2	1865	77	55	103	27%	2.1	1.1	15	0%	20%	1%	38%	40%
Alt 3	1865	76	55	102	27%	2.2	1.1	15	0%	20%	1%	38%	40%
Alt 4	1486	60	49	119	23%	1.5	.7	12	0%	20%	2%	51%	27%
PFA Areas													
Alt 1	178	160	74	234	54%	11.8	3	23	0%	0%	51%	0%	49%
Alt 2	178	87	58	70	29%	5.3	1.9	18	0%	20%	4%	21%	55%
Alt 3	178	84	57	69	27%	5.3	2.4	18	0%	20%	0%	17%	63%
Alt 4	105	91	60	76	29%	4.6	2.2	19	0%	20%	0%	0%	80%
Nest Areas													
Alt 1	45	167	75	160	59%	12	2.8	35	0%	0%	0%	100%	0%
Alts 2, 3, & 4	45	96	61	103	35%	4.5	2.6	26	0%	0%	0%	100%	0%
MSO PAC treatments													
Alt 1	379	105	63	54	32%	10.6	5.9	22					
Alts 2	379	91	59	68	29%	7.1	5.4	22					
Alts 3	379	92	60	68	30%	7.3	5.5	22					
Alt 4	230	92	60	145	33%	4.9	2.3	22					
MSO PAC Nest –Burn Only													
Alts 1	97	60	49	43	17%	6.1	2.8	15					
Alts 2 & 3	97	42	40	21	11%	5.5	2.8	12					

Ponderosa Pine – Mormon Mountain

Ponderosa Pine Fuels Reduction – 776 acres
MSO PAC Fuels Reduction – 1083 acres
MSO Nest Fuels Reduction - Burn Only – 52 acres
MSO Nest Roost Recovery – 22 acres

Alternative 1 – No Action

Direct & Indirect Effects

The current stand conditions are shown in Table 30. Stand conditions under the No Action Alternative for 20 and 40 years from now are shown in Table 31 and Table 32. Current conditions show that all the ponderosa pine stands have high BA, ranging from 146 to 173 ft^2, which means canopy cover is high. All treatment areas have very high numbers of trees per acre, ranging from 600 to 1210 TPA. All these factors contribute to the percent max SDI being well into the extreme range of density, which means these stands are likely to experience higher levels of mortality and high levels of insect and disease.

Under the No Action Alternative, forested areas would remain in an even-aged condition; stands would continue to be dominated by trees in the 5 to 18 inch dbh size classes. Mature and old forest conditions would continue development at a slow pace and be at risk of increased rates of mortality (Ritchie et al. 2008, Davis et al. 2007).

Over 40 years, canopy cover would increase, basal areas would increase, and trees per acres would decrease. Closed crown canopies result in decreased sunlight to the forest floor, decreased understory productivity and diversity, increased inter-tree competition, decreased tree health, growth and vigor, increased insect and disease-related mortality especially in older age classes, and decreased horizontal heterogeneity. Gambel oaks would continue to be shaded out and decline as a result of competition induce mortality from ponderosa pine. The number of medium and large sized snags would increase overtime due to competition-induced mortality.

Alternatives 2, 3, & 4

Effects common to all proposed actions:
All of the treatments described below would have a prescribed broadcast burn applied after vegetation treatments are completed. Burning of dead and down fuels would release nutrients and create small patches of mineral soil, which would facilitate future regeneration. Prescribed burns cause between 5 percent to 13 percent reduction in stand density of max SDI. The mortality caused by prescribed fire is random and unpredictable in terms of identifying which trees would be killed by the burn. However overall mortality is greatly reduced compared to a prescribed burn applied to the No Action Alternative. A high percent of the mortality caused by the prescribed burn occurs to the oak.

Ponderosa Pine Fuels Reduction – **Alts 2, 3 & 4: 776 acres**
This treatment comprises all of the ponderosa pine stands outside of the MSO PACs within the Mormon Mountain portion of this project. All of the pine stands are classified as pine-oak and are considered recovery habitat for MSO. Treatment are designed to reduce tree densities, maintain a minimum of 40 percent canopy cover, create small regeneration openings, maintain or

create patch heterogeneity, and reduce competition to large oaks. No oaks or trees over 24 inches dbh would be cut. Stands would also have an initial entry prescribed burn several years after completion of vegetation treatments.

MSO PAC Fuels Reduction – **Alts 2 & 3: 1083 acres; Alt 4: 1061 acres**
These treatments would apply to ponderosa pine stands that are located within the six MSO PACs located within Mormon Mountain part of the project. Up to 1061 acres would be mechanically treated with conventional ground based harvesting methods. An additional 22 acres would be treated using cable yarding in Alternative 2, or with a steep slope harvester in Alternative 3; under Alternative 4 those acres would not be treated mechanically. Treatments would maintain a minimum of 40 percent canopy cover, openings would be created from 0.1 to 2.5 acres in size in up to 10 percent of the treatment acres. Treatments would be designed to maintain or create horizontal and vertical patch heterogeneity. Tree species diversity would be maintained with an emphasis on protecting large oaks. Trees over 18 inches dbh would not be cut except for on 22 acres of proposed cable yarding in Alternative 2 where it would be necessary to cut all trees (including those larger than 18 inches dbh) for the purpose of creating the cable yarding corridors. No snags would targeted for removal except for in the 22 acres of cable yarding in Alternative 2, in which this report assumes all snags would be cut due to safety requirements for logging operations.

MSO Nest Fuels Reduction - **Burn Only –Alts 2 & 3: 52 acres; Alt 4: 0 acres**
Burn only treatments would occur in MSO nest cores under Alternatives 2 and 3 to achieve fuels reduction objectives. The nest cores would not be treated under Alternative 4. Burning of MSO nest cores would occur outside of the breeding season.

MSO Nest Roost Recovery – **Alt 2, 3, & 4: 22 acres**
Treatments would be designed to reduce fire hazard while maintaining minimum required stand attributes for MSO nest roost habitat.

Direct & Indirect Effects of MSO Habitat common from Alternatives 2, 3, and 4

Ponderosa Pine Fuels Reduction – **Alts 2, 3 & 4: 776 acres**
As shown in Table 30, under all action alternatives, BA would be reduced from 161 to 60 ft^2, canopy cover would fall from 74 percent to 49 percent, TPA would be reduced to 534 from 730, and percent max SDI would fall from 74 percent to 31 percent. This overall reduction in density along with creating 10 percent openings across each stand would have the effect of opening up the forest floor to sunlight and increasing understory diversity. The open stand conditions would allow for prescribed fire to be reintroduced in a safe and controlled manner. Competition between trees for space, water, and sunlight would be greatly reduced, increasing individual tree health and growth. Levels of dwarf mistletoe rating would be reduced through selective cutting of infected trees. The creation of regeneration openings would allow for groups of regeneration throughout the stand and create desired vertical diversity. The treatments would also leave trees in groups and clumps which would also create horizontal diversity. Small to medium size ponderosa pines would be removed from around large oaks and have the effect of reducing competition to the oaks. Oak crowns would increase in size and volume and mast (acorn) production would increase.

The effects twenty years after treatment are shown in table 29. Basal Area and canopy cover increase slightly, however TPA and percent max SDI have decreased due to the effects of the prescribed fire reducing the number of small Gambel oak stems. The number of snags increases

but is less than the No Action Alternative due to the reduced competition between trees from the thinning and prescribed burn treatments, which increase tree health and thus results in less trees dying and becoming snags.

Table 32 shows stand conditions 40 years after treatment. Basal Area and canopy cover, TPA, and percent max SDI have all accrued a healthy increase but still continue to be significantly lower than the No Action Alternative. The regeneration openings that were created now contain young trees that are starting at add to the canopy cover. The increased percent max SDI would almost be in the high density range, where the stands would start to see marked declines in understory production, competition among trees and reduced tree growth and vigor. Despite the increased stand density, this treatment area would still be benefitting from the thinning and prescribed burning treatment after 40 years.

MSO PAC Fuels Reduction – **Alts 2 & 3: 1083 acres; Alt 4: 1061 acres**
The effects of this treatment would be very similar between the different action alternatives. Alternative 2 would have 22 acres of treatment implemented using cable harvesting. Within those 22 acres, all snags would be felled and left in place due to operation safety requirements for cable yarding. Cable yarding also requires the construction of corridors for the cables to yard out the logs to be removed. Alternative 3 would implement on those same 22 acres using specialized steep slope harvesters. While the steep slope harvesting machines are similar to ground based equipment, they are not as maneuverable on steep slopes as they are on flatter ground. The limited maneuverability may require the removal of snags, oaks, or trees over 18 inches dbh only when necessary for the machine to operate safely. However the removal of these forest components is anticipated to be negligible and would not impact the ability of those areas to meet desired conditions. Alternative 4 would not treat those 22 acres. Under all the action alternatives, the remaining acres would be treated using conventional ground based harvesting methods. Treatment intensity would remain the same across all alternatives. The overall difference between the three alternatives in this treatment area would be very small because the 22 acres that would be treated differently is a fraction of the total acres.

As shown in

Table 33, in this treatment BA would be reduced from 161 to 63 ft^2, canopy cover would fall from 74 percent to 50 percent, TPA would be reduced to 515 from 1210, and percent max SDI would fall from 72 percent to 28 percent. This overall reduction in density along with creating 10 percent openings across each stand would have the effect of opening up the forest floor to sunlight and increasing understory diversity. The open stand conditions would allow for prescribed fire to be reintroduced in a safe and controlled manner. Levels of dwarf mistletoe rating would be reduced through selective cutting of infected trees. The creation of regeneration openings would allow for groups of regeneration throughout the stand and create desired vertical diversity. The treatments would also leave trees in groups and clumps, which would also create horizontal diversity. Small to medium size ponderosa pines would be removed from around large oaks and have the effect of reducing competition to the oaks. Oak crowns would increase in size and volume and mast (acorn) production would increase.

The effects 20 years after treatment are shown in Table 34. Basal Area and canopy cover increase slightly, however TPA and percent max SDI have decreased due to the effects of the prescribed fire reducing the number of small Gambel oak stems.

Table 33 shows stand conditions 40 years after treatment. Basal Area and canopy cover, TPA, and percent max SDI have all accrued a healthy increase but still continue to be significantly lower than the No Action Alternative. The regeneration openings created during implementation would now contain young trees that are starting to add to the canopy cover. The increased percent max SDI is still solidly in the moderate density range. Despite the increased stand density, this treatment area would benefit from the thinning and prescribed burning treatment after 40 years.

MSO Nest Fuels Reduction - Burn Only –**Alts 2 & 3: 52 acres; Alt 4: 0 acres**
There are 52 acres of identified ponderosa pine forest with in the MSO nest cores. The prescribed burn treatment would have the effect of reducing basal area from 146 to 122 ft^2, canopy cover would be lowered from 72 percent to 67 percent. Trees per acre would drop from 600 to 325. The percent max SDI is reduced from the extreme density of 61 percent to the high density of 48 percent. The number of medium (greater than 12 inches dbh) and large (greater than 18 inches dbh) snags more than doubles after treatment. Prescribed fire would have the effect of killing approximately 275 trees (according to modeling). However prescribed fire would not reduce basal area by a correspondingly large percent because the treatment would likely kill mostly small oak trees. Most of the trees greater than 18 inches dbh are anticipated to survive prescribed burning.

After 20 years the BA, canopy cover, and percent max SDI would all have increased since the prescribed burn, but would still be appreciably lower than the No Action Alternative. However the treatment area would start to once again experience tree competition and possible competition-induced mortality.

After 40 years, the BA, canopy cover, and percent max SDI would all have increased, yet would still be lower than under the No Action Alternative. The number of trees greater than 18 inches dbh would also have greatly increased; however the anticipated increase in density means the treatment area would continue to experience tree competition and competition-induced mortality.

MSO Nest Roost Recovery – **Alts 2, 3, & 4: 22 acres**

This treatment area was identified as nest roost recovery habitat as part of an earlier analysis related to the Four Forests Restoration Initiative (4FRI). This stand would be treated to meet the minimum habitat requirements for MSO nest roost recovery habitat. Basal area would be reduced from 173 to 120 ft², canopy cover would be reduced from 76 to 67 percent, trees per acre would be reduced from 949 to 906, and percent max SDI would be reduced from 87 to 64 percent. The percent of BA from 12 to 18" dbh would increase from 17% to 19% while the % of BA in trees greater than 18" would drop from 61% to 49%. Stand density would still be very high, and competition-induced mortality would still occur after treatment. Stand exam data also shows this stand contains a high number of large trees (39 over 18 inches dbh). This treatment would reduce the number of trees over 18 inches dbh to approximately 19 TPA immediately after treatments.

In twenty years, BA and canopy cover would be slightly higher; however due prescribed burning, TPA would drop to 448 TPA, and percent max SDI would also drop to 60 percent. There would not be as many snags per acre compared to the No Action Alternative. For alternatives 2, 3, & 4, basal area would be 131 and trees greater than 18" dbh would be 22 tpa. The percent BA from 12 to 18" dbh would be 30% for all three action alternatives, while the percent BA in trees greater than 18" dbh would be 57%. Twenty years after treatment this stand would meet all minimum desired conditions for MSO Nest Roost Recovery Habitat of at least 30% BA in the 12-18" dbh size class and 30% BA in trees greater than 18" dbh, along with 120 BA and 12 trees greater than 18" dbh.

After 40 years, BA, canopy cover, percent max SDI, and tree over 18 inches dbh would have increased while TPA and average snags per acre would have decreased. For alternatives 2, 3, & 4, basal area would be 154 and trees greater than 18" dbh would be 24 tpa. The percent BA from 12 to 18" dbh would be 30% for all three action alternatives, while the percent BA in trees greater than 18" dbh would be 56%. Forty years after treatment this stand would meet all minimum desired conditions for MSO Nest Roost Recovery Habitat of at least 30% BA in the 12-18" dbh size class and 30% BA in trees greater than 18" dbh, along with 120 BA and 12 trees greater than 18" dbh. After 40 years the decrease in snags would be the result of no new snags being created by disturbance agents such as fire or dwarf mistletoe. This stand does not have any recorded dwarf mistletoe.

Table 30: Stand values of current conditions and post treatment conditions for Ponderosa Pine Fuels Reduction treatments. Mormon Mountain, FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	% BA 12-18"	% BA 18"+
Ponderosa Pine										
Alt 1	776	161	74	730	74%	4.3	0.5	16		
Alts 2, 3, & 4	776	60	49	534	31%	4.1	0.5	9		
MSO PAC treatments										
Alt 1	1083	161	74	1210	72%	4.9	0.9	12		
Alt 2	1083	63	50	515	28%	4.6	0.9	13		
Alt 3	1083	63	50	515	28%	4.7	0.9	13		
Alt 4	1061	63	50	517	28%	4.7	0.9	13		
MSO PAC Nest –Burn Only*										
Alts 1 & 4	52	146	72	600	61%	4.4	.5	10		
Alts 2 & 3	52	122	67	325	48%	12.4	1.2	11		
MSO Nest Roost Recovery										
Alt 1	22	173	76	949	87%	5	1.3	39	17%	61%
Alts 2, 3, & 4	22	120	67	906	64%	4.8	1.3	19	19%	49%

*Burn only treatment modeled in 2016

Table 31: Average stand values of no action and proposed alternatives projected 20 years out for ponderosa pine stands. Mormon Mountain, FWPP.

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	% BA 12-18"	% BA 18"+
Ponderosa Pine										
Alt 1	776	177	77	598	76%	6.9	1.1	23		
Alts 2, 3, & 4	776	65	51	222	28%	2.1	.8	11		
MSO PAC treatments										
Alt 1	1083	180	77	901	73%	7.9	1.2	18		
Alt 2	1083	69	53	207	27%	2.5	1.4	15		
Alt 3	1083	69	53	206	27%	2.5	1.4	15		
Alt 4	1061	70	53	209	27%	2.5	1.4	15		
MSO PAC Nest –Burn Only										
Alts 1 & 4	52	165	75	500	62%	7.1	1.1	15		
Alts 2 & 3	52	137	70	295	50%	7.6	1.3	15		
MSO Nest Roost Recovery										
Alt 1	22	182	77	742	86%	7.6	2.7	43	21%	68%
Alts 2, 3, & 4	22	131	69	448	60%	3.8	1.2	22	30%	57%

Table 32: Average stand values of no action and proposed alternatives projected 40 years out for ponderosa pine stands. Mormon Mountain, Flagstaff Watershed Protection Project, Coconino National Forest.

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	% BA 12-18"	% BA 18"+
Ponderosa Pine										
Alt 1	776	184	78	506	75%	9.8	2.1	30		
Alts 2, 3, & 4	776	85	58	208	34%	2.3	1.1	14		
MSO PAC treatments										
Alt 1	1083	197	79	714	73%	9.5	2	26		
Alt 2	1083	86	58	194	31%	2.2	1.6	19		
Alt 3	1083	86	58	194	31%	2.2	1.6	19		
Alt 4	1061	87	58	195	31%	2.3	1.6	19		
MSO PAC Nest –Burn Only										
Alts 1 & 4	52	182	77	440	63%	8	1.6	26		
Alts 2 & 3	52	150	72	258	51%	7.8	1.8	27		
MSO Nest Roost Recovery										
Alt 1	22	190	78	608	86%	7.5	3	40	21%	68%
Alts 2, 3, & 4	22	154	73	410	67%	2.5	.7	24	30%	56%

Mixed Conifer- Dry Lake Hills

Goshawk Nest Fuels Reduction – 54
Goshawk PFA Fuels Reduction - 181
Mixed Conifer Fuels Reduction - 1158
Mixed Conifer Fuels Reduction Hand Thin – 132
MSO Nest Fuels Reduction Hand Thin – 122
MSO Nest Fuels Reduction Burn Only – 163
MSO Nest Roost Recovery Hand Thin – 72
MSO Nest Roost Recovery Burn Only - 37
MSO PAC Fuels Reduction – 816
MSO PAC Fuels Reduction Hand Thin – 108
Burn Only – 138 acres

Alternative 1 – No Action

Direct & Indirect Effects

The current stand conditions are shown in Table 35. Stand conditions under the No Action Alternative for 20 and 40 years are shown in
Table 3136Table 3237. Current conditions show that the majority of mixed conifer stands have high BA, ranging from 122 to 157 ft², which means that canopy cover is also high. All treatment areas also have very high numbers of TPA, ranging from 476 to 2986. These factors contribute to most of the mixed conifer areas being in the extreme range of density of percent max SDI. The majority of the mixed conifer stands are uneven-aged with trees in all size classes.

Under the No Action Alternative, ponderosa pine and aspen would not be able to regenerate in the current closed canopy conditions and would continue to slowly die out of the stands. In the absence of disturbance or fires, white firs and Douglas-firs would continue to increase and eventually dominate the overstory. In the absence of fire, shade tolerant species such as white fir and (to a lesser extent) Douglas-fir would continue to regenerate in very high numbers of many hundreds to thousands of trees per acre. The increased density contributes to fire hazard and increases the likelihood of epidemic levels of insect and/or disease mortality. Also, because these species are shade tolerant, their lower limbs are slow to die off and remain on the tree much longer than shade intolerant species which would create an increased ladder fuel hazard. Mature and old forest conditions would continue development at a slow pace and be at risk of increased rates of mortality (Ritchie et al. 2008, Davis et al. 2007).

Over 40 years, canopy cover would increase, BA would increase, and TPA would decrease. Closed crown canopies result in decreased sunlight to the forest floor, decreased understory productivity and diversity, increased inter-tree competition, decreased tree health, growth and vigor, increased insect and disease-related mortality especially in older age classes, and decreased horizontal heterogeneity. Regeneration would comprise mostly of white fir and Douglas-fir. Early seral species aspen and ponderosa pines would continue to be shaded out by more shade tolerant white fir and Douglas-fir. The number of medium and large-sized snags would increase overtime due to competition-induced mortality.

The 72 acres of proposed MSO Nest Roost Recovery hand thinning treatment area does not currently meet the minimum desired conditions for MSO Nest Roost Recovery Habitat, nor would they meet them after 40 years of no action. After 40 years the density of trees within this

proposed treatment area would remain extremely high at 79% of max SDI and there would be 1,904 trees per acre. This area would continue to be highly susceptible to high severity wildfire and to increased rates of mortality from insects and disease (Ritchie et al. 2008, Davis et al. 2007).

Alternatives 2, 3, & 4

Effects common to all proposed actions:

All of the treatments described below would have a prescribed broadcast burn applied after vegetation treatments are completed. Burning of dead and down fuels would release nutrients and create small patches of mineral soil, which would facilitate future regeneration. Prescribed burns cause between up to 3 percent reduction in stand density of max SDI. The mortality caused by prescribed fire is random and unpredictable in terms of identifying which trees would be killed by the burn. However overall mortality is greatly reduced compared to a prescribed burn applied to the No Action Alternative.

Goshawk Nest Fuels Reduction – Alts 2, 3, & 4: 54 acres

There are two identified goshawk nest areas that occur in the Dry Lake Hills. The action alternatives would mechanically treat only the Schultz PFA nest area (the Orion nest is located within the Orion MSO PAC nest and would be treated in the proposed burn-only for MSO Nest cores). This area would be treated following the Forest Plan standards and guidelines for managing northern goshawk PFA nest centers. The Schultz PFA nest area is 100 acres, of which only 54 acres is comprised of mixed conifer and thus included in this discussion (the remaining 45 acres of the goshawk nest acres are classified as ponderosa pine). The treatment would also follow the recommendations for treatment of MSO recovery habitat. Treatments would retain the majority of trees over 18 inches dbh and would not cut trees over 24 inches dbh. Stands would also have an initial entry prescribed burn several years after completion of vegetation treatments.

Goshawk PFA Fuels Reduction - Alts 2, 3, & 4: 181 acres

There are two identified PFAs in the Dry Lake Hills. Only the Schultz Pass PFA contains mixed conifer outside of MSO PACs. The action alternatives would mechanically treat mixed conifer within the Schultz Pass PFA following the Forest Plan standards and guidelines for managing northern goshawk PFAs outside of nest centers. The treatment would also follow the recommendations for treatment of MSO recovery habitat. Treatments would retain the majority of trees over 18 inches dbh and would not cut trees over 24 inches dbh. Stands would also have an initial entry prescribed burn several years after completion of vegetation treatments.

Mixed Conifer Fuels Reduction – Alt 2: 1140 acres; Alt 3: 1158 acres; Alt 4: 542
Mixed Conifer Fuels Reduction Hand Thin – Alt 2: 132 acres; Alt 3: 85 acres

These treatments would apply to the majority of mixed conifer stands that are located outside of the four MSO PACs located within the Dry Lake Hills. Under Alternative 2 and 3, 1,140 acres and 1,158 acres would be mechanically treated respectively, and an additional 132 acres under Alternative 2 and 85 acres under Alternative 3 would be treated by hand. Alternative 4 would treat fewer acres in this treatment type: 542 acres of mechanical treatment only (no hand thinning).

Treatments would maintain a minimum of 40 percent canopy cover, openings would be created from 0.1 to 2.5 acres in size in up to 10 percent of the treatment acres. Treatments would be designed to maintain or create horizontal and vertical patch heterogeneity. Tree species diversity would be maintained. Trees over 24 inches dbh would not be cut except for on 514 acres of

proposed cable yarding in Alternative 2, where it would be necessary to cut all trees (including those larger than 24 inches dbh) for the purpose of creating the cable yarding corridors.

No snags would be targeted for cutting under this treatment except in the 514 acres of cable yarding in Alternative 2, and 425 acres of helicopter logging in Alternative 3 in which this report assumes all the snags would be cut due to safety requirements. Hand thinning treatments would generally only treat up to 9 inches dbh. Stands would also have an initial entry prescribed burn several years after completion of vegetation treatments.

MSO Nest Fuels Reduction Hand Thin – Alts 2, 3 & 4: 122 acres
This treatment only affects the Schultz MSO nest roost core, and is the same under all action alternatives. Stand exam data showed that this nest area contains nearly 2,000 TPA, of which over 1,500 were under 5 inches dbh in size. The revised MSO Recovery Plan does not recommend thinning of MSO nest cores; however due to the extreme density of conifers in this stand, hand thinning is proposed to reduce the TPA and stand density to allow for the safe and effective reintroduction of prescribed fire to this area. Only trees up to 5 inches dbh would be thinned.

MSO Nest Fuels Reduction Burn Only –Alts 2 & 3: 163 acres; Alt 4: 0 acres
The burn only treatments would occur in MSO nest cores. Burning of MSO nest cores would occur outside of the breeding season.

MSO Nest Roost Recovery Hand Thin – Alts 2 & 3: 72 acres
A district-wide assessment of available nest roost recovery habit identified a need to designate 72 acres of nest roost habitat within the mixed conifer recovery habitat within DLH. The area designated was assessed for treatment needs. It was determined that a hand thinning treatment would meet the objectives of reducing fire hazard while meeting the intent of the revised MSO Recovery Plan guidelines. As outlined in the description of effects below, the proposed treatment would lower the basal area from 148 to 99 ft^2. This would lower the basal area below the recommended threshold of 120 ft^2. However this stand has a very high number of trees per acre, 2986, of which approximately 2600 are less than 9 inches dbh. Thinning this stand to 120 ft^2 of BA would require leaving an additional 74 trees per acre between 5 and 9 inches dbh. After 40 years there would be 16 trees per acre greater than 18 inches dbh compared to the proposed action which would have 17 trees per acre greater than 18 inches dbh. The model shows that over 40 years after thinning to 99 ft^2 BA compared to 120 ft^2 BA would also have greater fuels reduction benefits, such as less greater average crown base height, less crown bulk density, and greater crowning and torching indexes.

MSO PAC Fuels Reduction – Alt 2: 788 acres; Alt 3: 816 acres; Alt 4: 337 acres
MSO PAC Fuels Reduction Hand Thin – Alts 2 & 3: 108 acres; Alt 4: 121 acres
These treatments would apply to mixed conifer stands that are located within the four MSO PACs within the DLH. Up to 816 acres would be mechanically treated and up to 121 acres would be treated by hand. Treatments would maintain a minimum of 40 percent canopy cover; openings would be created from 0.1 to 2.5 acres in size in up to 10 percent of the treatment acres. Treatments would be designed to maintain or create horizontal and vertical patch heterogeneity. Tree species diversity would be maintained with an emphasis on protecting large oaks. Trees over 18 inches dbh would not be cut except for on 316 acres of proposed cable yarding in Alternative 2, where it would be necessary to cut all trees (including those larger than 18 inches dbh) for the purpose of creating the cable yarding corridors. No snags would be targeted for removal except for safety purposed in the 316 acres of cable yarding in Alternative 2 and 251

acres of helicopter logging in Alternative 3. Hand thinning treatments would generally only treat up to 9 inches dbh.

Burn Only – Alts 2 & 3: 138 acres; Alt 4: 67 acres
The burn only treatments would occur on top of Mt. Elden in the old Radio Fire burn area. The analysis of the burn only treatment is not included in the tables below as there is no stand exam data collected in those areas. The analysis of the burn only area will be included in the narrative below.

Direct & Indirect Effects of MSO Habitat common to Alternatives 2, 3 and 4

Goshawk Nest Fuels Reduction – Alts 2, 3, & 4: 54 acres
This treatment is an intermediate thin from below. Basal areas would be reduced from 157 to 71. Canopy cover would decrease from 74 to 53 percent and TPA would be reduced from 931 to 204. No trees over 18 inches dbh would be cut, of which there is an average of 20 TPA. This treatment would also move the stand from an extreme density rating to a moderate density rating. Competition between trees for space, water, and sunlight would be greatly reduced, increasing individual tree health and growth. This treatment would not create any regeneration openings. There would be a response from the understory from opening up the overstory canopy, but without creating regeneration openings the increased understory productivity would be short lived as the overstory crowns grow and close in.

After 20 years, BA, canopy cover, and percent max SDI would increase, but still be substantially lower than the No Action Alternative. Also, the number of large trees would not be as great compared to the No Action Alternative. This is not because large trees would be cut; rather it is because there would be fewer middle size trees available in the more open treated conditions to grow into large trees than there would be in the dense conditions of the No Action Alternative.

After 40 years, BA, canopy cover, and percent max SDI would increase, but still be significantly lower than the No Action Alternative. The stand density would now be in the high range and the trees would start competing for resources amongst each other. After 40 years, the stand conditions would still be much more open than current conditions, showing that the positive effects of thinning and burning would last at least 40 years. The number of large trees would still not be as great compared to the No Action Alternative.

Goshawk PFA Fuels Reduction - Alts 2, 3, & 4: 181 acres
Treatment within the Schultz PFA areas would reduce the BA from 135 to 76 ft^2 for Alternatives 2, 3 and 4; canopy cover would be reduced from 70 to 55 percent, and TPA would decrease from 850 to 115. Even though the average stand canopy cover would be 55 percent, the Forest Plan standards of maintaining 60 percent canopy cover within VSS 4-6 would still be maintained; the average is lower than 60 percent when areas of VSS 1-3 are factored in. Percent max SDI would decrease from 57 percent (extreme density) to 24 percent (low density). The trees per acre of trees larger than 18 inches dbh would decrease from 21 to 15.

Openings would be created in up to 20 percent of the treatment area. The overall reduction in density along with creating 20 percent openings across each stand would have the effect of opening up the forest floor to sunlight and increasing understory diversity. The creation of 20 percent openings would allow for early seral species such as aspen and pine to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics. The open stand conditions would allow for prescribed fire to be reintroduced in a safe and controlled manner.

Selective cutting of trees infected with dwarf mistletoe would help to reduce overall infection levels in the stand and improve overall stand health.

In 20 years, BA, canopy cover, TPA, percent max SDI, and trees greater than 18 inches dbh would all have increased post-treatment. The number of trees would have increased due to regeneration in the openings. The number of large snags would have decreased slightly to 2.2 snags per acre and would only be slightly less than the 2.6 snags per acre in the No Action Alternative. The number of trees greater than 18 inches dbh would have gone up slightly but would be approximately half that of the No Action Alternative. The number of 18 inch dbh trees would be less due to the removal of some of the medium size trees from which are no longer available to grow into future large trees. In order for the action alternatives to have the same number of large trees as the no action alternative would require thinning from below in order to leave all the large and medium size trees. This would also require the removal of most of the smaller trees and prevent the creation of regeneration openings thus not meeting the desired condition of creating an uneven-age heterogeneous stand structure. It would also remove all of the lower age class tress that would eventually grow into large, mature trees in the coming decades.

In 40 years, BA, canopy cover, and SDI would all still be significantly lower than the No Action Alternative. The number of snags and large trees would be less than the No Action Alternative. Trees over 18 inches dbh would be less than the No Action Alternative: 19 TPA compared to 27 TPA due to the same issue discussed in the previous paragraph. However, it is important to note that under Alternatives 2 and 3, the large trees would have much less likelihood of mortality because they would be much more resilient to inter-tree competition, drought, insects and disease. Overall stand density is still greatly lower than current conditions, showing that thinning and burning treatments would have the positive effect of lower stand density for at least 40 years.

MSO Nest Fuels Reduction – Hand Thin – Alts 2, 3, & 4: 122 acres
Basal area would be reduced from 122 to 111 ft^2, canopy cover would be reduced from 67 to 65 percent, TPA would be reduced from 1952 to 540, the percent max SDI would be reduced from 54 to 41 percent (which is still in the high range).

After 20 years, basal area and canopy cover would still be the same. TPA would be significantly lower due to anticipated tree mortality from prescribed burning. With fewer trees, the percent max SDI would be slightly lower but still within the high density range.

After 40 years, basal area and canopy cover would have increased greatly and exceed current conditions. While TPA would be lower and average tree size would be greater, canopy density would be very high. Understory production and diversity would be less than current conditions.

MSO PAC Fuels Reduction Hand Thin – Alts 2 & 3: 108 acres; Alt 4: 121 acres
Field visits to these areas determined that desired could be met or nearly met by using hand thinning methods. Compared to the other mixed conifer treatment areas, the hand thinning treatment areas are either less dense and or have smaller average size trees. Most of the hand thinning areas are located on steep rocky south facing slopes with poorer site conditions. Where practical and feasible, leave trees would be arranged in groups and clumps, small openings would be created for regeneration. This would allow for more sunlight to reach the forest floor and allow for greater production and diversity of the understory species. Despite cutting almost 90 percent of the trees, the basal area would only be reduced by 23 percent. Canopy cover is reduced

from 67 to 60 percent. The percent max SDI is reduced from a high density rating to a moderate density rating.

After 20 years, BA, canopy cover, TPA, and percent max SDI would all be lower than immediately initial post-treatment. This is the result of prescribed burning, which would have a higher than average amount of tree mortality due to the high levels of dwarf mistletoe in the stand. However BA and canopy cover would still be relatively high compared to the desired condition for mixed conifer.

After 40 years, the treatment area would have recovered to its pre-vegetation treatment conditions for BA and canopy cover. TPA would continue to decline as a result of the high levels dwarf mistletoe infection.

Burn Only – Alts 2 & 3: 138 acres; Alt 4: 67 acres
This treatment would be similar to burning a grassland. This area which was part of the Radio Fire was replanted in the early 1980s but much of the planting failed due to poor genetic stock being used. Some of the few surviving saplings from that planting would be killed. Burning of dead and down fuels in the old burn would release nutrients and create small patches of mineral soil, which would facilitate future regeneration. In Alternative 4, only 67 acres would be burned instead of 138 acres.

Direct & Indirect Effects of MSO Habitat Specific to Alternatives 2 and 3

Mixed Conifer Fuels Reduction – Alt 2: 1140 acres; Alt 3: 1158 acres
Treatment within Mixed Conifer Fuels Reduction areas would reduce the BA from 141 to 62 ft^2 for both Alternative 2 and 3; canopy cover would be reduced from 71 to 50 percent, and TPA would decrease from 1130 to 213 for Alternative 2 and 198 for Alternative 3. Percent max SDI would decrease from 57 percent (extreme density) to 22 and 21 percent (low density) under Alternatives 2 and 3, respectively. The creation of 10 percent openings would allow for early seral species such as aspen and pine to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics.

The main difference between Alternatives 2 and 3 is the harvest methods used. Alternative 2 would treat 514 acres (out of 1140) by cable yarding, which would require the cutting of all snags both within and immediately adjacent to cable corridors, as well as the removal of all trees (including those over 18 inches dbh) within the cable corridors. Despite the creation of the cable corridors, the average number trees over 18 inches dbh post-treatment within this treatment area would be about the same in this alternative compared to Alternative 3. Alternative 3 would include 425 acres of helicopter logging, which would require the removal of all snags in those units for operational safety.

After treatment there would be fewer large snags per acre under each alternative: 2.1 snags for Alternative 2 and 2.4 snags for Alternative 3 compared to snags per acre in the No Action Alternative. Openings would be created in up to 10 percent of the treatment area. The overall reduction in density along with creating 10 percent openings across each stand would have the effect of opening up the forest floor to sunlight and increasing understory diversity. The open stand conditions would allow for prescribed fire to be reintroduced in a safe and controlled manner. Selective cutting of trees infected with dwarf mistletoe would help to reduce overall infection levels in the stand and improve overall stand health.

In 20 years, BA, canopy cover, SDI, would all still be about the same as post-treatment due to mortality associated with prescribed fire. The number of trees would have increased due to regeneration in the openings. The number of large snags would be about the same and is only slightly less than the No Action Alternative. The number of trees greater than 18 inches dbh would have gone up slightly but would still be less than the No Action Alternative. The number of 18 inch dbh trees would be less due to the removal of some of the medium size trees from which are no longer available to grow into future large trees. In order for the action alternatives to have the same number of large trees as the no action alternative would require thinning from below in order to leave all the large and medium size trees. This would also require the removal of most of the smaller trees and prevent the creation of regeneration openings thus not meeting the desired condition of creating an uneven-age heterogeneous stand structure.

In 40 years, BA, canopy cover, and SDI would all still be significantly lower than the No Action Alternative. The number of snags would be about the same as the No Action Alternative. Trees over 18 inches dbh would be less than the No Action Alternative: 17 TPA compared to 23 TPA due to the same issue discussed in the previous paragraph. Overall stand density is still greatly lower than current conditions, showing that thinning and burning treatments would have the positive effect of lower stand density for at least 40 years.

Mixed Conifer Fuels Reduction Hand Thin – Alt 2: 132 acres; Alt 3: 85 acres
Field visits to the area proposed for Mixed Conifer Fuels Reduction hand-thinning treatment determined that treatment by cable yarding would not be desirable or practical due to the high cost and potential resource damage from building temporary roads through very rocky, inaccessible ground in order to access those areas. Alternative 2 would hand thin 132 acres; under Alternative 3, only 85 acres would be hand thinned in this treatment area. The reduction in the number hand thinning acres in Alternative 3 is due to more acres that could have material removed by helicopter without the anticipated resource damage associated with cable corridors. Most of the hand thinning areas are located on steep rocky slopes with poorer site conditions.

Basal area would be reduced from 140 to 102 ft^2, canopy cover would be reduced from 71 to 63 percent, TPA would be reduced from 1248 to 275, the percent max SDI would be reduced from 59 to 35 percent.

After 20 years, basal area and canopy cover would be lower as the result of the mortality associated with prescribed burning. TPA would also be lower due to tree mortality from prescribed burning. With fewer trees, the percent max SDI would now be in the moderate density range.

After 40 years, basal area and canopy cover would have increased. The density rating would still be in the moderate range. Even after 40 years, this treatment area would still meet fuels reduction targets.

MSO Nest Fuels Reduction Burn Only –Alts 2 & 3: 163 acres
Low intensity prescribed burning would be conducted with the purpose of reducing dead and down fuel loading, creating some mortality of smaller trees in the denser patches, and raising canopy base heights. Prescribed burning would create a short term spike of smaller sized snags. Small opening may be created where the prescribed burning created pockets of mortality. The small openings would allow for early seral species such as aspen and pine to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics. Any small openings created would also have the effect of increasing understory production and diversity.

MSO Nest Roost Recovery Hand Thin – Alts 2 & 3: 72 acres
Basal area would be reduced from 148 to 99 ft², canopy cover would be reduced from 72 to 62 percent, TPA would be reduced from 2986 to 421, and the percent max SDI would be reduced from 71 to 34 percent.

After 20 years, basal area and canopy cover would be somewhat lower due to mortality caused by prescribed burning. TPA would also be lower due to tree mortality from prescribed burning. With fewer trees, the percent max SDI would also be lower. Increased sunlight to the forest floor would increase understory production and diversity. Basal area would be 78 and trees greater than 18" dbh would be 11 tpa. The percent BA from 12 to 18" dbh would be 56% for both action alternatives, while the percent BA in trees greater than 18" dbh would be 30%.

After 40 years, basal area and canopy cover would have increased back to conditions similar to post vegetation treatment.
Basal area would be 93 and trees greater than 18" dbh would be 17 tpa. The percent BA from 12 to 18" dbh would be 30% for both action alternatives, while the percent BA in trees greater than 18" dbh would be 62%. Forty years after treatment this stand will meet minimum desired conditions for MSO Nest Roost Recovery Habitat of at least 30% BA in the 12-18" dbh size class and 30% BA in trees greater than 18" dbh, along with and 12 trees per acre greater than 18" dbh, but would not have the minimum 120 BA. However, under Alternatives 2 and 3, the stand would be much more fire resilient, tree health would be greater and more resilient to major drought events and trees would have greater resistance to bark beetle attacks.

MSO PAC Fuels Reduction – Alt 2: 788 acres; Alt 3: 816 acres
Treatment under Alternatives 2 and 3 would reduce the BA from 137 to 81 ft² for Alternative 2 and 82 ft² for Alternative 3. Canopy cover would be reduced from 70 to 57 percent, and TPA would be reduced from 1143 to 306 for Alternative 2 and 256 for Alternative 3. Percent max SDI would be reduced from 56 percent (extreme density) to 29 percent (moderate density). The creation of 10 percent openings would allow for early seral species such as aspen and pine to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics.

The primary difference between the two alternatives is harvest method utilized for material extraction. In Alternative 2 there would be 316 acres (out of 788 acres) treated by cable yarding, which would require the cutting of all snags within and adjacent to the cable corridor, and removal of all trees (including those over 18 inches dbh) within the cable corridors. In Alternative 3 there would be 251 acres (out of 816 acres) of helicopter logging, which would require the removal of all snags in those units for operational safety. After treatment there would be slightly fewer large snags per acre in Alternatives 2 and 3 than under the No Action Alternative: 2.3 and 2.7 respectively, compared to 4.0 No Action Alternative. Openings would be created in up to 10 percent of the treatment area. The overall reduction in density along with creating 10 percent openings across each stand would have the effect of opening up the forest floor to sunlight and increasing understory diversity. The open stand conditions would allow for prescribed fire to be reintroduced in a safe and controlled manner. Selective cutting of trees infected with dwarf mistletoe would help to reduce overall infection levels in the stand and improve overall stand health and promote development of VSS 3 and 4 trees to VSS 5 and 6 trees.

In 20 years, BA, canopy cover, SDI, would have increased slightly. The number of large snags and trees greater than 18 inches dbh would be slightly less than the No Action Alternative.

In 40 years, BA, canopy cover, and SDI would all be greatly lower than the No Action Alternative. The number of snags and large trees would still be slightly lower compared to the No Action Alternative. The number of 18 inch dbh trees would be less due to the removal of some of the medium size trees from which are no longer available to grow into future large trees. In order for the action alternatives to have the same number of large trees as the no action alternative would require thinning from below in order to leave all the large and medium size trees. This would also require the removal of most of the smaller trees and prevent the creation of regeneration openings thus not meeting the desired condition of creating an uneven-age heterogeneous stand structure. Thinning from below would also create an age class "gap" so that in several decades there would be few or no trees available to replace the large mature trees that die off. Because the treatments would reduce recruitment of future large trees in the coming decades and stand conditions would be more open, there would be slightly fewer large trees available to become snags and the large trees available would have less competitive stress, thus would be healthier and would be less likely to die and become snags.

Direct & Indirect Effects to MSO Habitat from Alternative 4

Mixed Conifer Fuels Reduction – Alt 4: 542 acres

The effects of the Mixed Conifer Fuels Reduction Treatment would be very similar to the effects described above for Alternatives 2 and 3. The two main differences would be that only 542 acres would be treated as opposed to 1140 acres or 1158 acres under Alternative 2 and 3, respectively, and there would be no steep slope harvesting methods used to treat stands in Alternative 4.

MSO PAC Fuels Reduction – Alt 4: 337 acres

The 337 acres treated in this alternative is a smaller sub-set of the 816 acres that would be treated in the other two action alternatives. This alternative does not utilize any steep slope harvesting methods. While the BA and canopy cover post-treatment on these acres would be similar to Alternatives 2 and 3, this subset would have a higher number of snags. In both 20 and 40 years, this subset would continue to have very similar conditions. The effects would be the same as described for Alternatives 2 and 3, but on fewer acres.

Table 33: Stand values of current conditions and post treatment conditions for Mixed Conifer Fuels Reduction treatments. Dry Lake Hills, FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	% BA 12-18"	% BA 18"+
Goshawk Nest Fuels Red.										
Alt 1	54	157	74	931	72	7.4	3.3	20		
Alts 2, 3, & 4	54	71	53	204	28	7.2	3.2	20		
Goshawk PFA Fuels Red.										
Alt 1	181	135	70	850	57	6.6	2.7	21		
Alts 2, 3, & 4	181	76	55	115	24	6.4	2.6	15		
Mixed Conifer Fuels Red.										
Alts 1	1124	141	71	1130	57	9.6	4.0	13		
Alt 2	1124	62	50	213	22	5.0	2.1	12		
Alt 3	1158	62	50	198	21	5.8	2.4	12		
Alt 4	542	63	50	217	22	8.9	3.8	12		
Mixed Conifer Fuels Red. Hand Thin										
Alts 1	132	140	71	1248	59%	11	4.3	12		
Alt 2	132	102	63	275	35%	10.4	4.1	12		
Alt 3	85	102	63	275	35%	10.4	4.1	12		
MSO Nest Fuels Red. Hand Thin										
Alts 1	122	122	67	1952	54	6.2	4.3	13		
Alts 2, 3 & 4	122	111	65	540	41	5.9	4.1	13		

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18”	% BA 12-18”	% BA 18”+
MSO Nest Fuels Reduction Burn Only*										
Alts 1 & 4	163	139	70	476	50	5.9	2.6	24		
Alts 2 & 3	163	108	64	174	34	16.3	6.5	21		
MSO Nest Roost Recovery Hand Thin										
Alts 1 & 4	72	148	72	2986	71	16.23	2.4	7	25%	11%
Alts 2 & 3	72	99	62	421	34	15.4	2.3	7	38%	16%
MSO PAC Fuels Reduction										
Alt 1	788	137	70	1143	56	9.2	4.0	14		
Alt 2	788	81	57	306	29	5.1	2.3	14		
Alt 3	816	82	57	256	29	5.8	2.7	14		
Alt 4	337	81	57	201	27	6.9	3.8	16		
MSO PAC Fuels Reduction Hand Thin										
Alt 1	108	120	67	1067	53	7	4.1	13		
Alts 2 & 3	108	93	60	126	29	6.8	4	13		
Alt 4	121	93	60	126	29	6.8	4	13		

***Burn only treatments were modeled to occur 2016**

Table 34: Average stand values of no action and proposed alternatives projected 20 years for Mixed Conifer Fuels Reduction treatments. Dry Lake Hills, Flagstaff Watershed Protection Project, Coconino National Forest.

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	% BA 12-18"	% BA 18"+
Goshawk Nest Fuels Red.										
Alt 1	54	185	78	853	78	6.3	2.1	33		
Alts 2, 3, & 4	54	83	57	223	32	4.2	2.6	24		
Goshawk PFA Fuels Red.										
Alt 1	181	159	74	767	62	7.9	2.6	26		
Alts 2, 3, & 4	181	83	57	202	29	4.4	2.2	17		
Mixed Conifer Fuels Red.										
Alts 1	1124	169	75	1016	64	5.0	2.3	18		
Alt 2	1124	62	50	340	24	3.4	1.9	14		
Alt 3	1158	62	50	342	24	3.5	2.0	15		
Alt 4	542	64	50	344	24	4.3	2.7	15		
Mixed Conifer Fuels Red. Hand Thin										
Alts 1	132	171	76	1116	66%	4.8	2.4	16		
Alt 2	132	92	60	131	27	6.3	2.9	17		
Alt 3	85	92	60	131	27	6.3	2.9	17		
MSO Nest Fuels Red. Hand Thin										
Alts 1	122	184	78	1477	71	4.1	2	16		
Alts 2, 3 & 4	122	111	65	199	35	4.5	2.4	15		
MSO Nest Fuels										

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18”	% BA 12-18”	% BA 18”+
Reduction Burn Only										
Alts 1 & 4	163	159	74	438	54	6.1	2.4	27		
Alts 2 & 3	163	118	66	201	36	9.7	4	22		
MSO Nest Roost Recovery Hand Thin										
Alts 1 & 4	72	173	76	2386	75	5.6	1.5	8	29%	12%
Alts 2 & 3	72	78	56	172	23	6	1.5	11	56%	30%
MSO PAC Fuels Reduction										
Alt 1	788	166	75	1022	63	5.4	2.4	19		
Alt 2	788	87	58	398	33	3.7	2.0	17		
Alt 3	816	86	58	379	33	3.9	2.2	17		
Alt 4	337	88	59	324	31	4.2	2.7	17		
MSO PAC Fuels Reduction Hand Thin										
Alt 1	108	140	71	976	57	5.9	2.8	15		
Alts 2 & 3	108	85	58	75	25	6.6	3.2	14		
Alt 4	121	85	58	75	25	6.6	3.2	14		

Table 35: Average stand values of no action and proposed alternatives projected 40 years for Mixed Conifer Fuels Reduction treatments. Dry Lake Hills, Flagstaff Watershed Protection Project, Coconino National Forest.

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	% BA 12-18"	% BA 18"+
Goshawk Nest Fuels Red.										
Alt 1	54	211	81	765	80	7.5	2	37		
Alts 2, 3, & 4	54	106	63	211	37	2.9	1.7	24		
Goshawk PFA Fuels Red.										
Alt 1	181	185	78	669	66	8.4	2.8	27		
Alts 2, 3, & 4	181	101	62	191	33	3.6	2	19		
Mixed Conifer Fuels Red.										
Alts 1	1124	193	79	885	68	5.1	1.8	23		
Alt 2	1124	77	56	320	27	2.0	1.5	17		
Alt 3	1158	77	55	322	27	2.0	1.5	17		
Alt 4	542	79	56	323	27	2.4	1.9	17		
Mixed Conifer Fuels Red. Hand Thin										
Alts 1	132	199	80	965	70%	3.8	1.6	23		
Alt 2	132	106	64	123	29%	3.7	2	22		
Alt 3	85	106	64	123	29%	3.7	2	22		
MSO Nest Fuels Red. Hand Thin										
Alts 1	122	225	83	939	77	6	1.5	19		
Alts 2, 3 & 4	122	142	71	183	41	3.3	1.3	20		

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18”	% BA 12-18”	% BA 18”+
MSO Nest Fuels Reduction Burn Only										
Alts 1 & 4	163	178	77	395	57	6	2.7	32		
Alts 2 & 3	163	131	69	145	38	6.1	3.3	28		
MSO Nest Roost Recovery Hand Thin										
Alts 1 & 4	72	200	80	1904	79	5.1	1.2	19	20%	22%
Alts 2 & 3	72	93	60	165	26	1.6	.8	17	30%	62%
MSO PAC Fuels Reduction										
Alt 1	788	194	79	885	68	5.1	1.9	24		
Alt 2	788	109	64	372	38	2.3	1.6	19		
Alt 3	816	108	64	355	38	2.5	1.7	20		
Alt 4	337	111	65	302	37	2.9	2.1	20		
MSO PAC Fuels Reduction Hand Thin										
Alt 1	108	165	75	890	62	6.4	2.5	17		
Alts 2 & 3	108	91	60	66	25	6.1	2.6	17		
Alt 4	121	91	60	66	25	6.1	2.6	17		

Mixed Conifer – Mormon Mountain

MSO Nest Fuels Reduction - Burn Only – 317 acres
MSO PAC Fuels Reduction – 509

Alternative 1 – No Action

Direct & Indirect Effects

The current and stand conditions are shown in Table 36. Stand conditions under the No Action Alternative for 20 and 40 years from now are shown in
Table 31. Current conditions show that the majority of mixed conifer stands have high BA ranging from 140 to 153 ft², which means that canopy cover is also high. All treatment areas have very high numbers of TPA, ranging from 868 to 888. All these factors contribute to most of the mixed conifer areas being in the upper end of the high or lower end of extreme range of density of percent max SDI. The majority of the mixed conifer stands are uneven-aged with trees in all size classes.

Under the No Action Alternative, ponderosa pine, Gambel oak and aspen would not be able to regenerate in the current closed canopy conditions and would slowly die out of the stands. In the absence of disturbance or fires, white fir and Douglas-fir would continue to increase and eventually dominate the overstory. In the absence of fire, shade tolerant species such as white fir and (to a lesser extent) Douglas-fir would continue to regenerate in very high numbers of many hundreds to thousands of trees per acre. The increased density contributes to fire hazard and increases the likelihood of epidemic levels of insect infestation and/or disease mortality. Also, because these species are shade tolerant, their lower limbs are slow to die off and remain on the tree much longer than shade intolerant species which would create an increased ladder fuel hazard. Mature and old forest conditions would continue development at a slow pace and be at risk of increased rates of mortality (Ritchie et al. 2008, Davis et al. 2007).

Over 40 years, canopy cover would increase, BA would increase, and TPA would decrease. Closed crown canopies would result in decreased sunlight to the forest floor, decreased understory productivity and diversity, increased inter-tree competition, decreased tree health, growth and vigor, increased insect and disease-related mortality (especially in older age classes), and decreased horizontal heterogeneity. Regeneration would be comprised mostly of white fir and Douglas-fir. Early seral species aspen, ponderosa pine and Gambel oak would continue to be shaded out by more shade tolerant white firs and Douglas-firs. The number of medium and large-sized snags would increase overtime due to competition-induced mortality.

Alternatives 2 & 3

Direct & Indirect Effects

Effects common to all proposed actions:
All of the treatments described below would have a prescribed broadcast burn applied after vegetation treatments are completed. Burning of dead and down fuels would release nutrients and create small patches of mineral soil, which would facilitate future regeneration. The mortality caused by prescribed fire is random and unpredictable in terms of identifying which trees would be killed by the burn.

MSO Nest Fuels Reduction - Burn Only – Alts 2 & 3: 317 acres
Under Alternatives 2 and 3, low intensity prescribed burning would be conducted with the purpose of reducing dead and down fuel loading, creating some mortality of smaller trees in the denser patches, and raising canopy base heights within MSO nest cores on Mormon Mountain. Prescribed burning would create a short term spike of smaller sized snags. Small openings may be created where the prescribed burning created pockets of mortality. The small openings would allow for early seral species such as aspen, pine and oak to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics. Any small openings created would also have the effect of increasing understory production and diversity. Prescribed burning would have the effect of reducing BA from 140 to 116 ft^2. TPA would be reduced from 868 to 364, and percent max SDI would be reduced from 54 to 39 percent.

In 20 years BA is projected to be 138 ft^2 and canopy cover would be 70 percent, which is similar to existing conditions.

Forty years after treatment, BA would be 164 ft^2, canopy cover would be 75 percent and percent max SDI would be 49 percent. While BA and canopy cover would exceed today's current condition, the percent max SDI would still be less.
Thus 40 years after treatment, the stand would include more large trees as a percentage of all trees, thereby being more in line with desired conditions compared to the No Action Alternative.

MSO PAC Fuels Reduction – Alts 2 & 3: 509 acres
These treatments would apply to mixed conifer stands located within the six MSO PACs within the Mormon Mountain area. Up to 509 acres would be mechanically treated. Treatments would maintain a minimum of 40 percent canopy cover; openings would be created from 0.1 to 2.5 acres in size in up to 10 percent of the treatment acres. The openings would allow for early seral species such as aspen, pine and oak to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics. Treatments would be designed to maintain or create horizontal and vertical patch heterogeneity. Tree species diversity would be maintained with an emphasis on protecting large oaks and aspen by thinning out conifers which overtop the oaks and aspen. Trees over 18 inches dbh would not be cut, except for on 52 acres of proposed cable yarding in Alternative 2 where it would be necessary to cut approximately 2 trees per acre larger than 18 inches dbh for the purpose of creating the cable yarding corridors. No snags would be cut under this treatment except for safety purposes in the 52 acres of cable yarding in Alternative 2.

Table 36 displays the post treatment stand values for the proposed treatments. The proposed treatments would reduce the BA from 153 to 86 ft^2 for Alternative 2, 87 ft^2 for Alternative 3, and 88 ft^2 for Alternative 4. Canopy cover is reduced from 73 to 59, and trees per acre are reduced from 888 to 274 for alternative 2 and 275 for alternative 3. Percent Max SDI is reduced from 56 percent (extreme density) to 29 percent (moderate density). One of the differences between the alternatives is harvest methods. In alternative 2 there would be 52 acres (out of 509) treated by cable yarding which would require the cutting of all snags and removal of approximately 2 trees per acre over 18" DBH within the cable corridors. After treatment there would be slightly fewer large snags per acre in alternative 2 compared to alternative 3; 7.8 versus 8.8 Openings would be created in up to 10% of the treatment area. The overall reduction in density along with creating 10% openings across each stand would have the effect of opening up the forest floor to sunlight and increasing understory diversity. The open stand conditions would allow for prescribed fire to be reintroduced in a safe and controlled manner. Selective cutting of trees infected with dwarf mistletoe would help to reduce overall infection levels in the stand and improve overall stand health.

Table 37 displays the stand values for the proposed treatments projected out 20 years. In 20 years, BA, Canopy Cover, SDI, would have increased slightly. The number of large snags and trees greater than 18" would be slightly greater than the No-Action Alternative.

Table 38 displays the stand values for the proposed treatments projected out 40 years. In 40 years, BA, Canopy Cover, and SDI would all continue to be greatly lower than the no action alternative. The number of snags and large trees would still be slightly lower compared to the no action.

Alternative 4

Direct & Indirect Effects

MSO Nest Fuels Reduction - Burn Only – Alt 4: 0 acres
Effects from Alternative 4 would be the same as those described for the No Action Alternative, as no treatment would occur within MSO nest cores on Mormon Mountain under Alternative 4.

MSO PAC Fuels Reduction – Alt 4: 448 acres
Effects would be the same as described for Alternatives 2 and 3 except to a lesser degree as fewer acres would be treated.

Table 36: Stand values of current conditions and post treatment conditions for Mixed Conifer Fuels Reduction treatments. Mormon Mountain, FWPP.

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"
MSO Nest Fuels Reduction - Burn Only								
Alt 1	317	140	71	868	54	24.5	9.4	20
Alts 2 & 3*	317	116	66	364	39	21.8	8.3	18
MSO PAC treatments								
Alt 1	509	153	73	888	56	22.8	9.2	22
Alt 2	509	86	58	274	29	18.6	7.8	22
Alt 3	509	87	59	275	29	20.8	8.8	22
Alt 4	448	88	59	290	30	20.7	8.7	23

*Burn only treatment modeled in 2016

Table 37: Average stand values of no action and proposed alternatives projected 20 years for Mixed Conifer Fuels Reduction treatments. Mormon Mountain FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"
MSO Nest Fuels Reduction - Burn Only								
Alt 1	317	174	76	805	61	3.9	2.4	24

Alts 2 & 3	317	138	70	351	44	4.4	2.6	22
MSO PAC treatments								
Alt 1	509	188	78	826	64	4.8	2.9	26
Alt 2	509	90	60	263	29	3.4	3.0	21
Alt 3	509	90	60	263	30	3.7	3.2	21
Alt 4	448	91	60	268	30	3.6	3.2	22

Table 38: Average stand values of no action and proposed alternatives projected 40 years for Mixed Conifer Fuels Reduction treatments. Mormon Mountain, FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"
MSO Nest Fuels Reduction - Burn Only								
Alt 1	317	206	80	708	63	4	1.9	28
Alts 2 & 3	317	164	75	326	49	3.8	2	27
MSO PAC treatments								
Alt 1	509	219	82	747	69	5.1	2.3	29
Alt 2	509	109	65	252	34	2.3	2.0	21
Alt 3	509	110	65	252	35	2.4	2.2	22
Alt 4	448	110	65	257	35	2.3	2.1	22

Wet Mixed Conifer- Mormon Mountain

MSO PAC Fuels Reduction – Wet Mixed Conifer – Alternatives 2 & 3: 180 acres

These treatments are located within the identified wet mix conifer cover type within the MSO nest cores on Mormon Mountain, and are only proposed in Alternatives 2 and 3. No wet mixed conifer exists within the DLH. The wet mixed conifer cover type is a mixed-severity fire regime. This area may or may not be out of the historic range of variability. These treatments are being conducted so that if and when this forest does burn, it burns as a mixed severity fire and not a severe one (e.g. complete crown fire)with undesirable effects.

Low intensity prescribed burning would be conducted with the main purpose of reducing dead and down fuel loading. The purpose of the treatment would not be to put fire on every acre of ground, but rather to reduce the amount of large woody debris that have resulted from a large amount of recent mortality. In areas outside of MSO nest cores where small groups of mature aspen occur from 0.25 to 2 acres in size, aspen snags and conifers would be felled by hand and jackstrawed in attempts to regenerate aspen in up to 10 percent of the stand. Aspen is an early seral species for wet mixed conifer and serves the purpose of breaking up the overstory fuel continuity. Dead and down material would be piled for burning to reduce the heavy fuel loading and allow for lower-intensity prescribed burning. Trees over 18 inches dbh would not be cut.

In Alternative 2, approximately 35 acres of wet mixed conifer would have cable corridors running through them for the purpose of accessing the dry mixed conifer stand on the slopes below. The areas between the cable corridors within the wet mixed conifer would not be thinned; however all trees and snags would be cut out of the corridors themselves. Within these 35 acres approximately 4 acres would be within the corridors.

Table 39 displays the post treatment stand values for the proposed treatments. The proposed treatments would reduce the BA from 155 to 129 ft² for Alternative 2 and 131 ft² for Alternative 3. Canopy cover would be reduced from 73 to 69 percent, and TPA would be reduced from 1164 to 704 for Alternative 2 and 715 for Alternative 3. Percent max SDI would also be reduced from 47 percent (high density) to 39 percent and 40 percent (high density) for Alternatives 2 and 3, respectively.

One other difference between the alternatives would be the difference in residual snags due to the cable corridors on 33 acres in Alternative 2, which would result in approximately 11.0 snags per acre versus 11.2 snags per acre in Alternative 3. Regeneration openings would be created in up to 10 percent of the treatment area. The overall reduction in density along with the increase in openings across each stand would have the effect of opening up the forest floor to sunlight and increasing understory diversity. The more open stand conditions would allow for aspen to regenerate and provide both horizontal and vertical diversity throughout the stand.

Table 40 displays the stand values for the proposed treatments projected out 20 years. In 20 years, BA and canopy cover would increase, but the percent max SDI would stay the same. The number of large snags would have gone down but would still be a relatively high at four snags per acre.

Table 41 displays the stand values for the proposed treatments projected out 40 years. In 40 years, BA, canopy cover, and SDI would all increase, but would still be lower than the No Action Alternative modeled out to 40 years. After 40 years BA, canopy cover, and percent max SDI would exceed or equal the current stand condition. The effectiveness of the treatment on stand density would last between 20 and 40 years. The creation of openings on up to 10 percent of the stand would have the effect of helping to maintain the uneven age conditions of the stand and promote the re-growth of declining aspen stands.

MSO Nest Fuels Reduction - Burn Only – Alternatives 2 & 3: 33 acres
Small openings may be created where prescribed burning would create pockets of mortality. The small openings would allow for early seral species such as aspen, and pine to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics. Any small openings created would also have the effect of increasing understory production and diversity. The burn only treatment would have the effect of reducing BA from 155 to 132 ft². TPA would be reduced from 1164 to 475, and percent max SDI would be reduced from 47 to 37 percent.

In 20 years BA would be 160 ft² and canopy cover would be 74 percent, which would exceed the current (2013) conditions. However percent max SDI would be 42 percent, which is less than current (2013) conditions. Thus the treatments would modify stand conditions to make large trees a greater percentage of all trees in the stand and thereby improve tree resilience and move the area on a trajectory more in line with desired conditions.

Forty years after treatment, BA, canopy cover and percent max SDI would be 195, 79 percent, and 49 percent, respectively. All three of those variables would exceed the current conditions

which mean the effects of the treatments would only last about 20 years before stand conditions return to or exceed current conditions.

Table 39: Stand values of current conditions and post treatment conditions for Wet Mixed Conifer Fuels Reduction treatments. Mormon Mountain, FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"
MSO Nest – Burn Only*								
Alt 1 & 4	33	155	73	1164	47	25.8	12.1	13
Alts 2, & 3	33	132	69	475	37	24.1	10.6	12
MSO PAC treatments								
Alt 1 & 4	180	155	73	1164	47	25.8	12.1	13
Alt 2	180	129	69	704	39	21.0	11.0	12
Alt 3	180	131	69	715	40	21.4	11.2	12

*Burn only treatment modeled in 2016

Table 40: Average stand values of no action and proposed alternatives projected 20 years for Wet Mixed Conifer Fuels Reduction treatments. Mormon Mountain, FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"
MSO Nest – Burn Only								
Alt 1 & 4	33	188	78	974	54	7.3	4.1	21
Alts 2, & 3	33	160	74	446	42	5.7	4.1	20
MSO PAC treatments								
Alts 1 & 4	180	188	78	974	54	7.3	4.1	21
Alt 2	180	139	71	414	39	4.9	3.9	19
Alt 3	180	141	71	409	39	5	4	19

Table 41: Average stand values of no action and proposed alternatives projected 40 years for Wet Mixed Conifer Fuels Reduction treatments. Mormon Mountain, FWPP

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"
MSO Nest – Burn Only								
Alt 1 & 4	33	218	82	769	59	6.8	3	25
Alts 2, & 3	33	195	79	403	49	4.8	2.9	23
MSO PAC treatments								

Alts 1 & 4	180	218	82	769	59	6.8	3	25
Alt 2	180	173	76	381	45	4.0	2.8	22
Alt 3	180	175	76	378	45	4.1	2.9	22

MSO Habitat- Mormon Mountain

Here is an analysis of the entire MSO habitat in the Mormon Mountain area. All of the different treatments that occur within the four different MSO habitat strata (MSO PACs, nest cores, recovery habitat, and nest roost recovery habitat) were combined to show the overall effects the treatments would have to MSO habitat.

Table 42 displays the value of the stands within the MSO PACS and recovery habitat, along with post-treatment data and stand conditions for all alternatives projected out 20 and 40 years.

Alternative 1 – No Action

Direct and Indirect Effects

Under the No Action Alternative, forest conditions within the protected and restricted stands would remain much as they are now. Currently in the pine-oak, large oaks are being over-topped by pine and shaded out, and as a result have small crown ratios and limited mast production. In the dry mixed conifer and wet mixed conifer, the more shade-tolerant conifers are also shading out the aspen.

In 40 years, canopy cover would increase, BA would increase, and TPA would decrease. Closed crown canopies would result in decreased sunlight to the forest floor, decreased understory productivity and diversity, increased inter-tree competition, decreased tree health, growth and vigor, increased insect and disease-related mortality especially in older age classes, and decreased horizontal heterogeneity. Oaks and aspen would continue to decline with little opportunity to regenerate.

Alternatives 2 & 3

MSO PAC treatments – Alts 2 & 3: 1772 acres

Table 42 below shows the stand attributes of all the combined treatments in all of the MSO PACs for Mormon Mountain. The average current condition has a BA of 158 ft², canopy cover of 74 percent, 1113 TPA, and percent max SDI is 65 percent. After treatment, those numbers would be reduced to: 76 ft² of BA, 54 percent canopy cover, 465 TPA, and 29 percent max SDI. The treatments would be designed to create a mosaic of patches and openings as recommended by the revised MSO Recovery Plan. Competition between trees for space, water, and sunlight would be greatly reduced, increasing individual tree health and growth. Small openings would be created across up to 10 percent of the area. The small openings would allow for early seral species such as aspen, pine, and oak to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics. Any small openings created would also have the effect of increasing understory production and diversity.

Alternatives 2 and 3 are very similar; however Alternative 2 would include 74 acres of treatment that would be conducted through cable yarding systems. Within those 74 acres, all snags would be felled and left in place due to operation safety requirements for cable yarding. Cable yarding also requires the construction of corridors for the cables to yard out the logs to be removed. An additional 35 acres of wet mixed conifer stands would have cable corridors constructed through

them to reach treatment areas below. These corridors would require approximately 10 percent of all tree species and sizes to be removed across the stand. This includes oak, maples, and trees over 18 inches dbh. Table 42below details the number of trees over 18 inches dbh that would be removed. Even though the cable corridors have the effect of cutting 10% of all the trees it does not have the effect of creating 10% regeneration openings. Cable corridors are approximately 12 ft. in width and occur approximately every 100 feet. The length of the corridors depends on the length of the steep slope or the limitation of the equipment. A long linear cable corridor does not constitute an opening. Where the cable corridor runs through an area identified as an opening, that area of the corridor would be counted as part of the opening. Where the corridor runs through the middle of a group, it would not be considered an opening. It is common to have spacing greater than 12 feet in-between trees within a group. The residual basal area, canopy cover, and density will still be approximately the same compared to treatments not using cable harvesting methods.

In Alternative 3 those 72 acres would be harvested using specialized steep slope harvesting machines which do not require the cutting of snags, oaks, or trees over 18 inches dbh. While the steep slope harvesting machines are similar to ground based equipment, they are not as maneuverable on steep slopes as they are on flatter ground. The limited maneuverability may require the removal of snags, oaks, or trees over 18 inches dbh only when necessary for the machine to operate safely. However the removal of these forest components is anticipated to be negligible and would not impact the ability of those areas to meet desired conditions. Because of the different harvesting methods, Alternative 2 would have slightly fewer large snags than Alternative 3: 3.9 versus 4.2. Also Alternative 3 would be slightly denser on average than Alternative 3.

After 20 years BA, canopy cover, and percent max SDI would increase slightly, while trees per acre would decrease to 244. Then after 40 years, BA, canopy cover, and percent max SDI would increase to 102 ft², 62 percent canopy cover, and 34 percent max SDI, all of which would still be lower than under the No Action Alternative. There would also be an average of 20 TPA over 18 inches dbh, which is a key threshold for meeting the old growth criteria for the Forest Plan. The benefits of the thinning and burning treatments would last beyond 40 years.

Table 42. The number and percent of trees per acre in Alternative 2 over 18 inches dbh cut within the cable harvesting areas in the MSO PACs of Mormon Mountain, FWPP. Trees cut over 18 inches dbh are only those which occur in the cable yarding corridors.

	Acres of Cable	TPA > 18" dbh cut	Total TPA >18" dbh	% of >18" trees cut
Mixed Conifer	52	1.7	15.7	10.8
Wet Mixed Conifer	33	2	13.3	15
Ponderosa Pine	22	.3	7.4	4.1
Average		1.5	13.3	11.3

MSO Nest Burn Only– Alts 2 & 3: 402

The only treatment that would occur in the MSO nest cores on Mormon Mountain would be a prescribed burn. After treatment, stand conditions would be reduced from 142 to 118 ft² of BA, from 71 to 66 percent for canopy cover, from 858 to 368 TPA, from 54 to 40 percent max SDI. TPA greater than 18 inches dbh would decrease slightly from 18 to 17. Competition between trees for space, water, and sunlight would be reduced, thus increasing individual tree health and growth. Small openings may be created where the prescribed burning creates pockets of

mortality. The small openings would allow for early seral species such as aspen, pine, and oak to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics. Any small openings created would also have the effect of increasing understory production and diversity.

After 20 years BA would be 140 ft^2 and canopy cover would be 70 percent, which is similar to current conditions. The percent max SDI would be 45 percent compared to the 54 percent in the current condition.

After 40 years, the overall density would be quite high, but still lower that the No Action Alternative after 40 years. The BA and canopy cover would be higher than current conditions whereas the TPA and percent max SDI would be lower. There would still be some benefits to the treatment after 40 years related to relative density and improving individual tree growth; however overall stand density and fire hazard would be greater than current conditions.

Recovery Habitat treatments – Alts 2, 3, & 4: 776 acres
The effects of this treatment are the same as described for Ponderosa Pine Fuels Reduction on page 70 of this document.

Nest Roost Recovery Habitat – Alts 2, 3, & 4: 22 acres
The effects of this treatment are the same as described for Ponderosa Pine Fuels Reduction on page 73 of this document.

Alternative 4

MSO PAC treatments – Alt 4: 1509 acres
This alternative would treat a smaller subset of Alternatives 2 and 3, the main difference being that no treatments would be conducted on steep slopes. The average density, number of TPA, and snags per acre would be less in Alternative 4 as the areas that are not being treated are not averaged into the numbers; those untreated areas are of high density and contain high numbers of TPA and snags per acre. Also the ratio of pine to mixed conifer is higher in this alternative. Since pine would be treated at a higher intensity, the average numbers for this sub-set of acres are lower than the other alternatives.

Recovery Habitat treatments – Alts 2, 3, & 4: 776 acres
The effects of this treatment are the same as described for Alternative 2 and 3.

Nest Roost Recovery Habitat – Alts 2, 3, & 4: 22 acres
The effects of this treatment are the same as described for Alternative 2 and 3.

Table 43 through Table 45: Within the Mormon Mountain portion of FWPP: Stand values for MSO PAC, recovery and nest roost recovery habitat. Values displayed are for current conditions, conditions after treatment, and stand values for treated and not treated areas projected out 20 years and 40 years.

Table 43: Current and Post Treatment

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	% BA 12-18"	% BA 18"+
Current Condition										
PAC – Alt 1	1772	158	74%	1113	65%	12.2	4.4	15		
PAC Nest Burn Only Alts 1 & 4	402	142	71%	858	54%	22.0	8.5	18		
Recovery - Alt 1	776	161	74%	730	74%	4.3	.5	16		
Nest Roost Recovery	22	173	76%	949	87%	5	1.3	39	17%	61%
After treatment										
PAC – Alt 2	1772	76	54%	465	29%	10.3	3.9	15		
PAC – Alt 3	1772	77	55%	466	30%	11.0	4.2	15		
PAC – Alt 4	1509	70	53%	450	29%	9.5	3.2	16		
PAC Nest Burn Only Alts 2 & 3*	402	118	66%	368	40%	20.8	7.6	17		
Recovery - Alts 2,3,4	776	60	49%	534	31%	4.1	.5	9		
Nest Roost Recovery Alts 2, 3, 4	22	120	67%	906	64%	4.8	1.3	19	19%	49%

Table 44: Projected 20 Years*

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	% BA 12-18"	% BA 18"+
No Action										
PAC	1772	183	77%	887	68%	6.9	2.0	21		
PAC Nest Burn Only Alts 1 & 4	402	174	76%	779	61%	4.6	2.4	23		
Recovery - Alt 1	776	177	77%	598	76%	6.9	1.1	23		
Nest Roost Recovery	22	182	77%	742	86%	7.6	2.7	43	21%	68%
After treatment										
PAC – Alt 2	1772	82	57%	244	29%	2.2	2.1	17		
PAC – Alt 3	1772	82	57%	243	29%	2.3	2.2	17		

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18”	% BA 12-18”	% BA 18”+
PAC – Alt 4	1509	76	55%	227	28%	2.0	1.9	17		
PAC Nest Burn Only Alts 2 & 3	402	140	70%	352	45%	4.9	2.6	21		
Recovery - Alts 2,3,4	776	65	51%	222	28%	2.1	.8	11		
Nest Roost Recovery Alts 2, 3, 4	22	131	69%	448	60%	3.8	1.2	22	30%	57%

Table 45: Projected 40 Years*

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18”	% BA 12-18”	% BA 18”+
No Action										
PAC – Alt 1	1772	205	80%	729	70%	8.0	2.2	27		
PAC Nest Burn Only Alts 1 & 4	402	204	80%	678	63%	4.7	2.0	27		
Recovery - Alt 1	776	184	78%	506	75%	9.8	2.1	30		
Nest Roost Recovery	22	190	78%	608	86%	7.5	3	40	21%	68%
After treatment										
PAC – Alt 2	1772	101	62%	230	33%	2.4	1.8	20		
PAC – Alt 3	1772	102	62%	229	34%	2.5	1.9	20		
PAC – Alt 4	1509	94	60%	213	32%	2.3	1.7	20		
PAC Nest Burn Only Alts 2 & 3	402	165	75%	324	49%	4.4	2.0	27		
Recovery - Alts 2,3,4	776	85	58%	208	34%	2.3	1.1	14		
Nest Roost Recovery Alts 2, 3, 4	22	154	73%	410	67%	2.5	.7	24	30%	56%

MSO Habitat- Dry Lake Hills

Here is an analysis of the entire MSO habitat in the Dry Lake Hills area, including ponderosa pine as well as dry and wet mixed conifer. All of the different treatments that occur within the four different MSO habitat strata (MSO PACs, nest cores, recovery habitat, and nest roost recovery habitat) were combined to show the overall effects the treatments would have to MSO habitat.

Error! Reference source not found., Table 49 and Table 50 display the value of the stands with in the MSO PACS and recovery habitat outside of the MSO PACs along with post treatment data and stand conditions for all alternatives projected out 20 and 40 years.

Alternative 1 – No Action

Direct and Indirect Effects

Under the No Action Alternative, forest conditions within the protected and restricted stands would remain much as they are now. Currently in the pine-oak, large oaks are being over-topped by pine and shaded out and as a result have small crown ratios and have limited acorn production. In the dry mixed conifer, aspen are being shaded out by the more shade tolerant conifers. In 40 years, canopy cover would increase, basal areas would increase, and trees per acres would decrease. Closed crown canopies would result in decreased sunlight to the forest floor, decreased understory productivity and diversity, increased inter-tree competition, decreased tree health, growth and vigor, increased insect and disease-related mortality especially in older age classes, decreased understory productivity and diversity, and decreased horizontal heterogeneity. Oaks and aspen would continue to decline with little opportunity to regenerate, reducing the stand biodiversity and spatial heterogeneity.

Alternatives 2 & 3

Direct and Indirect Effects

MSO PAC treatments – Alts 2: 1275 acres; Alt 3: 1303 acres

Table 46 below shows the stand attributes of all the combined treatments in all of the MSO PACs for DLH. The average current condition has a BA of 133 ft^2, canopy cover of 69 percent, 824 TPA, and % max SDI is 52 percent. After treatment, those numbers would be reduced to: 89 ft^2 of BA, 59 percent canopy cover, 184 TPA, and 20 percent max SDI. The treatments would be designed to create a mosaic of patches and openings as recommended by the revised MSO recovery plan. Competition between trees for space, water, and sunlight would be greatly reduced, increasing individual tree health and growth. Small openings would be created across at least 10 percent of the area. The small openings would allow for early seral species such as aspen, pine, and oak to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics. Any small openings created would also have the effect of increasing understory production and diversity.

Alternatives 2 and 3 are very similar. Alternative 2 has 360 acres of treatment that would be conducted utilizing cable yarding systems. Within those 360 acres, all snags would be felled and left in place due to operation safety requirements for cable yarding. Cable yarding also requires the construction of corridors for the cables to yard out the logs to be removed. These corridors would require approximately 10 percent of all tree species and sizes to be removed across the stand. This includes oak, maples, and trees over 18 inches dbh. Table 4646 below details the number of trees over 18 inches dbh that would be removed within MSO PACs. Also proposed in Alternative 2 is to treat 15 acres by cutting all the trees and leaving them in piles within the stand.

The reason for this proposal is due to the high cost of building a temp road to access this area and the undesired resource impact the construction of the temp road would cause.

In Alternative 3 those 134 acres would be harvested using specialized steep slope harvesting machines which do not require the cutting of snags, oaks, or trees over 18" dbh. While the steep slope harvesting machines are similar to ground based equipment they are not as maneuverable on steep slopes as they are on flatter ground. The limited maneuverability may require the removal of snags, oaks, or trees over 18" dbh only when necessary for the machine to operate safely. However the removal of these forest components is anticipated to be negligible and would not impact the ability of those areas to meet desired conditions. Also in alternative 3, 267 acres would be treated by helicopter logging. Within those 267 acres, all snags would be felled and left in place due to operation safety requirements for helicopter logging.

Because of the different harvesting methods, Alternative 2 would have slightly less large snags than Alternative 3. Also Alternatives 2 and 3 would be slightly denser on average than Alternative 4.

After 20 years BA, and canopy cover would be about the same, and % max SDI and large trees over 18 inches dbh would have increased slightly, while trees per acre will have decreased to 267. Then after 40 years, BA, canopy cover, and % max SDI would have increased to 102 ft² of BA, 62 percent canopy cover, and 26 percent max SDI, all of which would still be significantly lower than the no action alternative. There would also be an average of 20 TPA over 18 inches dbh which is a key threshold for meeting the old growth criteria for the Forest Plan. The benefits of the thinning and burning treatments would last longer than 40 years.

Table 46: The number and percent of trees per acre in Alternative 2 over 18 inches dbh cut within the cable harvesting areas in the MSO PACs of the Dry Lake Hills. Trees cut over 18 inches dbh are only those which occur in the cable yarding corridors.

	Acres of Cable	TPA > 18" dbh cut	Total TPA >18" dbh	% of >18" trees cut
Mixed Conifer	314	1.6	15.0	10.6
Ponderosa Pine	44	3.8	37.3	10.2
Average		1.9	17.7	10.5

MSO PAC Nest treatments – Alts 2 & 3: 382

There would be two different treatments in the DLH's nest cores. One nest core would receive a hand thinning treatment up to 5 inches dbh, with approximately 20 percent of that nest being deferred from thinning to retain vertical canopy diversity. The other two PAC nest cores would be treated with a prescribed burn. After treatment, the average nest core conditions would be reduced from 112 to 92 ft² of BA; 63 percent to 58 percent canopy cover; 845 to 256 TPA; 52 percent to 41 percent max SDI; and 16 to 15 TPA greater than 18 inches dbh. Competition between trees for space, water, and sunlight would be reduced, increasing individual tree health and growth. Small opening may be created where the prescribed burn created pockets of mortality. The small openings would allow for early seral species such as aspen, pine, and oak to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics. Any small openings created would also have the effect of increasing understory production and diversity. The open stand conditions would allow for prescribed fire to be reintroduced in a safe and controlled manner. Selective cutting of trees infected with dwarf mistletoe would help to reduce overall infection levels in the stand and improve overall stand health.

After 20 years BA would be 97 ft² and canopy cover 59 percent which would still be below current conditions. The % max SDI would be 27 percent compared to the 46 percent current condition. Then after 40 years, the BA and Canopy Cover would be similar to current conditions, but TPA would be much lower at 126, and % max SDI would also be significantly lower at 29 percent. The benefits of the treatments would last at least 40 years related to relative density and improving individual tree growth and resiliency to fire, insects and disease.

Recovery Habitat treatments – Alts 2: 1754 acres; Alt 3: 1741 acres
The recovery habitat treatment include treatments for mixed conifer and ponderosa pine and treatment methods include ground based logging, cable yarding, helicopter, steep slope harvester, and hand thinning. The treatments would be designed to create a mosaic of patches and openings as recommended by the revised MSO recovery plan. Competition between trees for space, water, and sunlight would be greatly reduced, increasing individual tree health and growth. Small openings would be created across at least 10 percent of the area, with the exception of 20 percent openings in 181 acres of PFA treatment and 263 acres in the Pine-oak. The small openings would allow for early seral species such as aspen, pine, and oak to regenerate and would have the effect of helping to maintaining uneven-age stand characteristics. Any small openings created would also have the effect of increasing understory production and diversity. The open stand conditions would allow for prescribed fire to be reintroduced in a safe and controlled manner. Selective cutting of trees infected with dwarf mistletoe would help to reduce overall infection levels in the stand and improve overall stand health.

The effect of treatment in the recovery habitat areas reduces the BA from 140 to 65 ft² for Alternative 2, and 64 ft² of BA for Alternative 3, canopy cover is reduced from 71 to 50, and trees per acre are reduced from 1039 to 255 for Alternative 2 and 244 for Alternative 3, and % max SDI is reduced from 54 percent (high density) to 22 percent (low density).

One of the differences between Alternatives 2 and 3 is harvest methods. In Alternative 2 there would be 514 acres (out of 1754) treated by cable yarding which would require the cutting of all snags and removal of trees over 24 inches dbh within the cable corridors. Table 47 summarizes the estimated number of trees over 24 inches dbh that would be removed, and **Error! Reference source not found.** below details the number of trees over 18 inches dbh that would be removed. In Alternative 3 there would be 425 acres of helicopter logging, which would require the removal of all snags for operational safety. Also in alternative 3 there would be 107 acres of steep slope harvesting. While the steep slope harvesting machines are similar to ground based equipment, they are not as maneuverable on steep slopes as they are on flatter ground. The limited maneuverability may require the removal of snags, oaks, or trees over 24 inches dbh only when necessary for the machine to operate safely. However the removal of these forest components is anticipated to be negligible and would not impact the ability of those areas to meet desired conditions. After treatment there would be 2 large snags per acre compared to 3 snags per acre in the no action alternative. The open stand conditions would allow for prescribed fire to be reintroduced in a safe and controlled manner. Selective cutting of trees infected with dwarf mistletoe would help to reduce overall infection levels in the stand and improve overall stand health by increasing the resiliency and resistance of trees to fire, insects and disease.

In 20 years, BA and canopy cover would all still be about the same. Trees per acres and % max SDI would be increased slightly, also the number of trees over 18 inches dbh would have increased from 12 to 14. The number of trees would have increased due to regeneration in the openings. The number of large snags is about the same and is only slightly less than the no action The number of trees greater than 18 inches dbh would have gone up slightly but would still be less than the No Action Alternative.

In 40 years, BA, Canopy Cover, and SDI are all still significantly lower than the No Action Alternative. The number of snags and large trees are about the same compared to the No Action Alternative. Trees over 18 inches dbh would be less than the No Action Alternative: 17 TPA compared to 26 TPA. Overall stand density is still greatly lower than current conditions showing that thinning and burning treatments would have the positive effect of lower stand density for at least 40 years.

Table 47: The number and percent of trees per acre in alternative 2 over 24 inches dbh cut within the cable harvesting areas in the MSO Recovery Habitat in the Dry Lake Hills, FWPP. Trees cut over 18 inches dbh are only those which occur in the cable yarding corridors.

Recovery Habitat	Acres	TPA > 24" dbh cut	Total TPA >24" dbh	% of >24" trees cut
MC	514	0.4	4.3	9.3

Nest Roost Recovery Habitat – Alts 2, & 3: 72 acres
The effects of this treatment are the same as described for MSO Nest Roost Recovery Hand Thin in the page 73 of this document.

Alternative 4

Direct and Indirect Effects

MSO PAC treatments – Alts 4: 688 acres
The effects to MSO PACs in alternative 4 are very similar to the effects described in alternatives 2 and 3. The areas treated in alternative 4 is focus on the Schultz and Elden PACs. No treatment would be done in the Orion or Weatherford PACs. Treatments would only be conducted with conventional ground based logging equipment or done with hand thinning. There would be no treatments on steeps slopes in this alternative. Some of the minor differences in stand attributes are that BA and canopy cover are a little lower after treatment, and the average number of large snags is higher compared to Alternatives 2 and 3. After 20 and 40 years the stand attributes are virtually identical, as are the overall treatment effects.

MSO PAC Nest treatments – Alts 4: 122
The effects of this treatment are the same as described for MSO Nest Roost Recovery Hand Thin in the page 73 of this document.

Recovery Habitat treatments – Alts 4: 1040 acres
The effects to recovery habitat in alternative 4 are very similar to the effects described in alternatives 2 and 3. The areas treated in alternative 4 are only treated with conventional ground based logging equipment. There would be no treatments on steeps slopes in this alternative. Some of the minor differences in stand attributes are that BA is a little lower after treatment, and the average number of large snags is higher compared to Alternatives 2 and 3. After 20 and 40 years the stand attributes are virtually identical, as are the overall treatment effects.

Error! Reference source not found. through Table 50: Within the Dry Lake Hills portion of FWPP: Stand values for MSO PAC, recovery and nest roost recovery habitat. Values displayed are for current conditions, conditions after treatment, and stand values for treated and not treated areas projected out 20 years and 40 years.

Table 48 Current and Post Treatment

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	% BA 12-18"	% BA 18"+
Current Condition										
MSO PAC	1275	133	69%	824	52%	9	4	16		
MSO PAC - Nest	382	112	63%	845	43%	5	3	16		
Nest Roost Recovery	72	148	72%	2986	71%	16.23	2.4	7	25%	11%
Recovery	1754	140	71	1039	54	7.9	3.3	14		
After treatment										
MSO PAC Alt 2	1275	89	59%	213	20%	6	3	17		
MSO PAC Alt 3	1303	90	59%	184	21%	7	4	17		
MSO PAC Alt 4	688	82	57%	144	18%	6	3	14		
MSO PAC - Nest Alts 2 & 3	382	92	58%	256	28%	12	5	15		
MSO PAC - Nest Alt 4	122	111	65%	540	41%	6	4	13		
Nest Roost Recovery – Alts 2 & 3	72	99	62%	421	34%	15.4	2.3	7	38%	16%
Recovery – Alt 2	1754	65	51	255	22	4.9	2.1	12		
Recovery – Alt 3	1741	64	50	244	22	5.3	2.2	12		
Recovery – Alt 4	1040	63	50	279	24	6.2	2.6	12		

Table 49: Projected 20 Years*

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	% BA 12-18"	% BA 18"+
No Action										
MSO PAC	1275	150	72%	735	44%	7	3	19		
MSO PAC - Nest	382	142	69%	673	46%	5	2	20		
Nest Roost Recovery	72	173	76%	2386	75%	5.6	1.5	8	29%	12%
Recovery	1754	167	75	939	61	4.7	2.0	22		
After treatment										
MSO PAC Alt 2	1275	90	59%	276	23%	5	3	19		
MSO PAC Alt 3	1303	89	59%	267	23%	6	3	18		
MSO PAC Alt 4	688	85	58%	224	20%	5	3	15		
MSO PAC - Nest Alts 2 & 3	382	97	59%	156	27%	8	3	17		
MSO PAC - Nest Alt 4	122	111	65%	199	35%	5	2	15		
Nest Roost Recovery – Alts 2 & 3	72	78	56%	172	23%	6	1.5	11	56%	30%
Recovery – Alt 2	1754	66	51	298	25	3.3	1.8	14		
Recovery – Alt 3	1741	65	51	305	25	3.3	1.8	15		
Recovery – Alt 4	1040	65	50	298	26	3.3	2.0	14		

Table 50: Projected 40 Years*

	Acres	BA	CC	TPA	% Max SDI	Snag 12+	Snag 18+	Trees >18"	% BA 12-18"	% BA 18"+
No Action										
MSO PAC	1275	165	74	638	47	7	3	23		
MSO PAC - Nest	382	163	72%	479	49%	6	2	24		
Nest Roost Recovery	72	201	80%	1904	79%	5.1	1.2	19	20%	22%
Recovery	1754	192	79	826	65	4.8	1.7	26		
After treatment										
MSO PAC Alt 2	1275	102	62	256	26	4	3	20		
MSO PAC Alt 3	1303	102	63	248	26	4	3	20		
MSO PAC Alt 4	688	101	62	208	23	4	2	20		
MSO PAC - Nest Alts 2 & 3	382	112	62%	126	29%	5	3	21		
MSO PAC - Nest Alt 4	122	142	71%	183	41%	3	1	20		
Nest Roost Recovery – Alts 2 & 3	72	93	60%	165	26%	1.6	.8	17	30%	62%
Recovery – Alt 2	1754	82	57	282	27	2.1	1.4	17		
Recovery – Alt 3	1741	81	56	288	28	2.0	1.4	17		
Recovery – Alt 4	1040	83	57	282	30	2.1	1.5	16		

Grassland Restoration

Grassland Restoration – Alternative 2 & 3: 60 acres; Alt 4: 53 acres

Mechanical treatment would remove encroaching post-settlement conifers and restore the pre-settlement tree density and patterns.

Alternative 1: No Action:

Direct and Indirect Effects

The No Action Alternative would indirectly affect grasslands within the project area. Over a minimum period of 40 years, grasslands would continue to experience pine and mixed conifer encroachment. As conifer density increases over time, grasslands would experience decreased productivity and diversity and loss of functionality in terms of hydrology, biodiversity, horizontal heterogeneity, and wildlife habitat diversity.

Alternative 2, 3 & 4

Direct and Indirect Effects

The action alternatives would reduce the number of trees within areas that were historically grassland vegetation types. Under each alternative, mountain grasslands would be restored to presettlement densities. Removal of the forest trees would stop or reduce encroachment upon the grasslands. Broadcast burning would release nutrients bound up by dead fuel and help with the grassland recovery process (Grady and Hart 2006). Removal of pine encroachment would increase sunlight to meadow floor and increase forb and grass production and understory diversity (Grady and Hart 2006). Indirect effects of reduced densities in these areas include restoration of their functionality in terms of wildlife habitat, watershed production, fire hazard, and scenic values. Presettlement densities are an important reference condition for restoration because they are the densities that evolved in these areas over centuries with fire, drought, frost, wildlife, insects, and disease.

Aspen Treatment

Aspen Restoration— Alternative 2 & 3: 22 acres; Alt 4: 2 acres

The aspen treatments described below and in the proposed action would be implemented on approximately 22 acres of pure aspen stands. Aspen treatments would consist mainly of removing conifers from aspen stands. The Mormon Mountain portion of the project does not contain any pure aspen stands. The treatment and effects to aspen within mixed conifer stands are addressed in the mixed conifer effects analysis portions of this document.

Alternative 1: No Action and Alternative 4

Direct and Indirect Effects

Table 51 displays existing conditions within the aspen cover type in the Dry Lake Hills project area. Under the No Action Alternative and 20 acres under Alternative 4, forest conditions within these stands would remain much as they are now. Only 2 acres of treatment within the pure aspen stands is proposed under Alternative 4; the remaining 20 acres would not be treated. Over 40 years (assuming no other dramatic aspen die-off occurs), basal areas of both aspen and conifer species would increase, and TPA would decrease. The basal area increase of the conifer trees would be greater than aspen and would result in a greater rate of decline for aspen trees per acre. Increased canopies of conifer species would compete with and shade out the shade-intolerant aspen crowns. Closed crown canopies would result in decreased sunlight to the forest floor, decreased understory productivity and diversity, increased inter-tree competition, decreased tree

health, growth and vigor, increased insect and disease-related mortality especially in older age classes,, and decreased horizontal heterogeneity (Zegler et al. 2012, Calder et al. 2011).

Alternative 2, 3 and 4
Direct and Indirect Effects
The treatment would have the effect of removing all conifer species from within the aspen stand. Immediately after treatment, total TPA would also decrease; however the number of aspen per acre would remain the same (see Table 51). This represents the removal of conifer encroachment from aspen clones. Compared to the No Action Alternative, when treated there would be the same basal area after 20 and 40 years; however the number of TPA would be significantly less and would be comprised solely of aspens.

Aspen clones would experience increased health, growth, and vigor due to the removal of conifer encroachment. With increased health and vigor, aspen would be more resilient and less susceptible to disease, with increased longevity. Alternatives 2 and 3 would result in increased biodiversity and improved wildlife habitat across the landscape. This stand is a young aspen stand that regenerated after the Radio Fire in 1977. The aspen clone may continue to expand over time but this expansion may be limited due to browse pressure from deer.

Table 51: Basal area and trees per acre for the Aspen Treatment areas under the Proposed Action Alternative. These numbers do not include anticipated aspen regeneration. Dry Lake Hills

TIME FRAME	BASAL AREA ALL SPECIES	BASAL AREA ASPEN	TREES PER ACRE ALL SPECIES	TREES PER ACRE ASPEN
EXISTING CONDITIONS	51	50	1687	739
POST-TREATMENT	50	50	738	739
No Action +20 YEARS	107	98	1493	652
Post Treatment +20 YEARS	106	106	712	712
No Action +40 YEARS	170	145	1190	519
Post Treatment +40 YEARS	170	170	626	626

Old-growth

In order for a stand to be designated as "existing old-growth," it must meet the minimum criteria for the structural attributes of old-growth forest as outlined in the Forest Plan (p. 70-2). The Existing Conditions section of this report contains the description of analysis levels and amount of old growth within the project area.

Alternative 1: No Action:
Direct and Indirect Effects
Under the no action alternative, stands would continue to develop at a slower pace and may eventually meet the criteria for old growth under the current Forest Plan unless destroyed via a wildfire or insect or disease. Current and increasing stand densities would continue to decrease the vigor and health of the stands. Due to high density and ladder fuel, fire hazard would increase

over time. Without treatment the rate of mortality of existing yellow pines would increase both as a result of insect and disease as well as a result of combined inter-tree competition and drought (Ritchie et al. 2008, Das et al. 2011). In the event of a high severity wildfire, which is more likely under the current conditions than the treated conditions, the old ponderosa pines are more prone to dying than younger ponderosa pines (Kolb 2007).

Alternatives 2, 3, and 4

Direct and Indirect Effects

These alternatives would designate 2366 acres to be managed towards old growth conditions in the Dry Lake Hill and 2196 acres in Mormon Mountain. See Table 52 for a breakdown of existing and designated acres by cover type. All of the acres in both project areas of existing or designated old growth would receive treatments under Alternatives 2 and 3. In Alternative 4, approximately 1,367 acres in DLH would be treated and 1,565 acres in MM would be treated. Treatments for each alternative would be designed to retain old trees and promote the growth of existing trees to become large old trees. The northern goshawk and revised MSO recovery plan both have guidelines to manage for uneven-age stand conditions. Most goshawk and MSO treatments across the project would retain groups of old trees even in stands not designated to be managed for old growth. As these stands continue to be managed for uneven-age conditions into the future, groups of old growth trees would be created across most stands and would be able to persist in a sustainable manner.

For stands that currently meet existing old growth requirements, treatments would be designed to retain all old growth characteristics, improve the health of old trees, and reduce the fire hazard for those stands. No yellow pines of any size would be cut under the action alternatives except for as needed for the creation of cable corridors for cable yarding operations in alternative 2, and for extenuating circumstances as outlined in the design features. Treatments would decrease the mortality rate of existing yellow pines and old mixed conifer trees in treated areas. After thinning, old ponderosa pines experience increased diameter growth, water uptake and resistance to bark beetles. Thinning in and around old ponderosa pines also reduces the likely hood of mortality following prescribed burning or a wildfire (Kolb 2007).

Table 52: Acres and percent of currently allocated acres being managed for old growth by cover type and site potential, and the proposed acres for future old growth management located within FWPP.

Project Area	Cover Type	Acres of Cover Type	Acres of Currently Allocated	Proposed Acres for Old Growth Management	Total % of Existing and Designated
Dry Lake Hills	Interior Ponderosa Pine – High	4336	1183	972	22%
	Mixed Species Group – High (Mixed Conifer)	3118	1450	1372	44%
	Aspen	22	0	22	100%
Mormon Mountain	Interior Ponderosa Pine – High	1924	53	1157	60%
	Mixed Species Group – High (Mixed Conifer)	1051	561	1039	99%

Figure 6: Existing old growth and designated developing old growth located within the Dry Lake Hills area

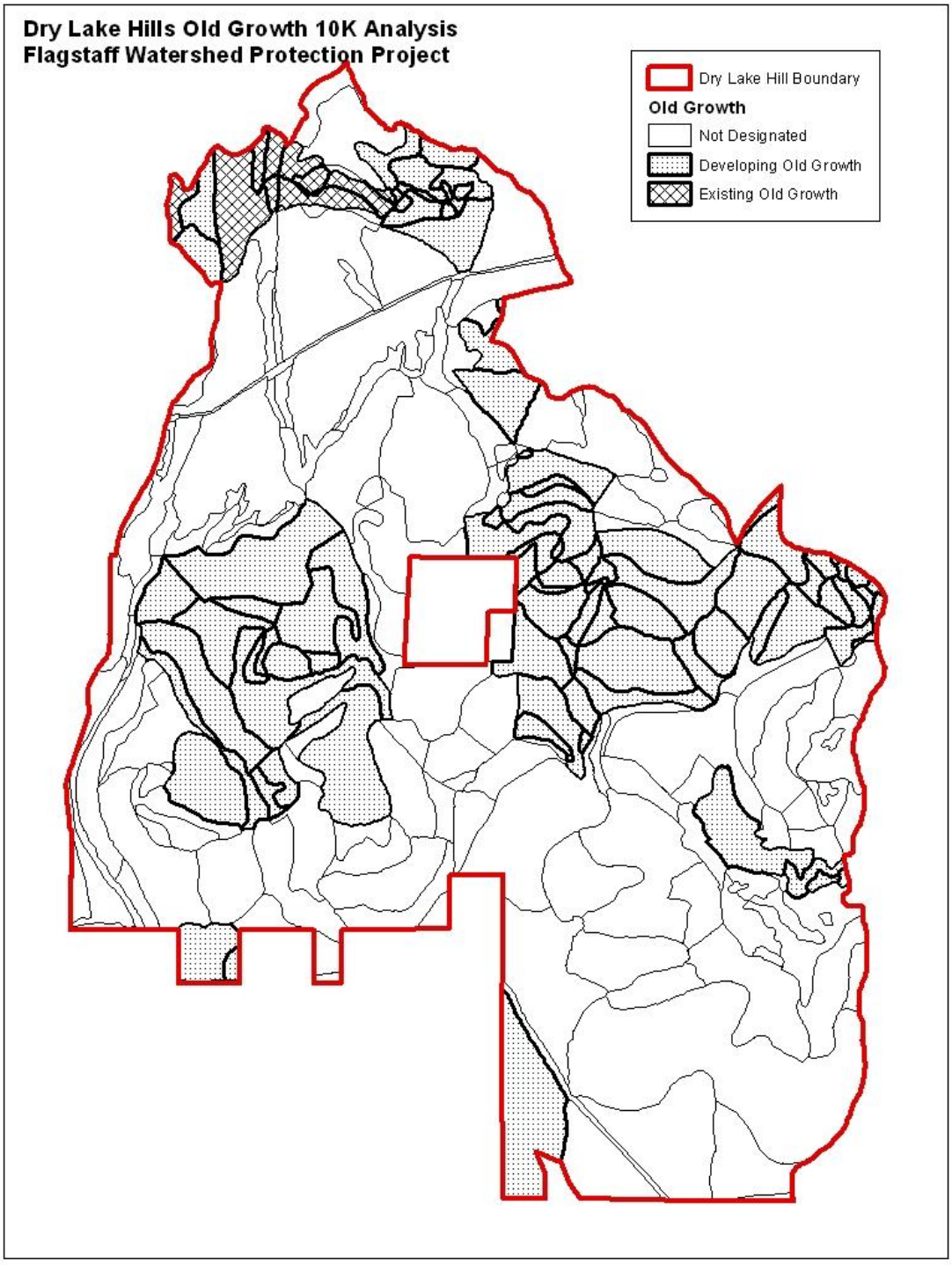
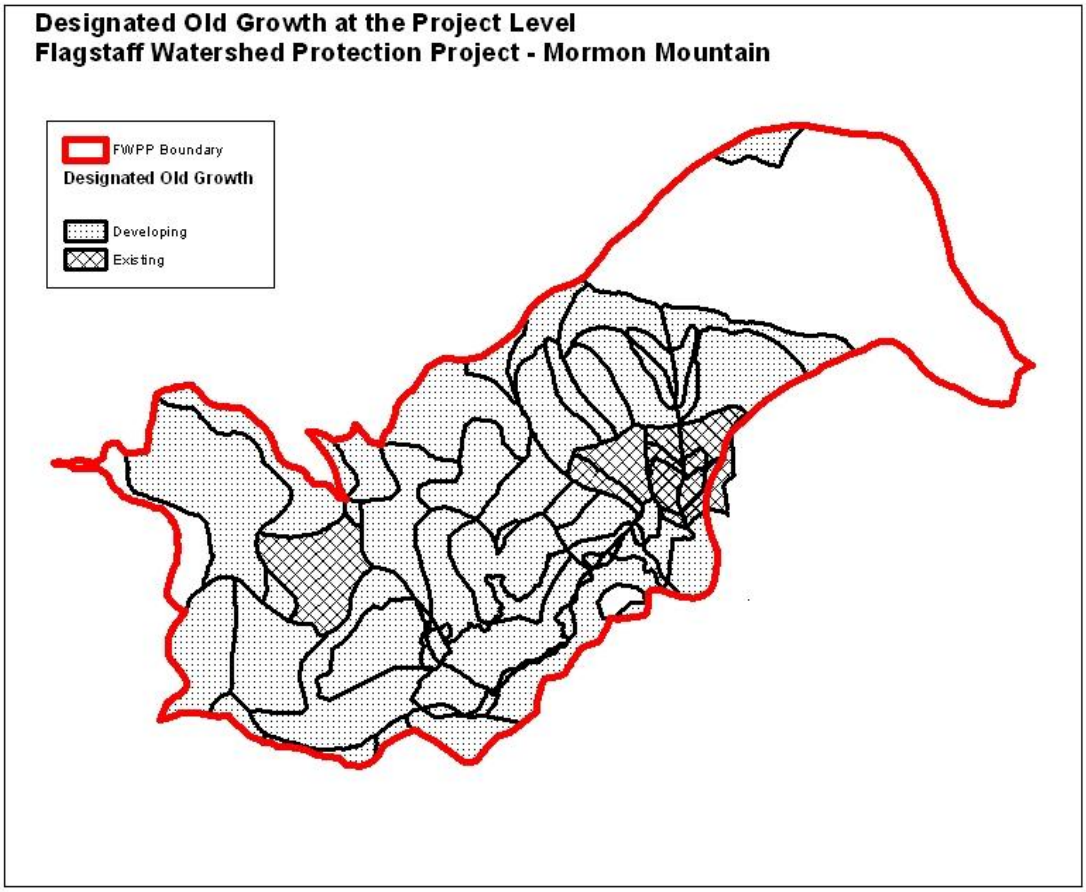


Figure 7: Existing old growth and designated developing old growth located within the Mormon Mountain area



Forest Health

Alternative 1: No Action:

Direct and Indirect Effects

Under the No Action Alternative, there would be no direct effect on dwarf mistletoe infection because no trees would be harvested. There would be no change in the level of dwarf mistletoe infection from existing levels. However, the No Action Alternative would indirectly affect the level of dwarf mistletoe infection over the long term. Under the No Action Alternative, dwarf mistletoe infection would continue to spread to more trees throughout and adjacent to infected stands, expanding at a rate of 1-2 feet per year. Increased dwarf mistletoe infection would result in reduced tree growth, reduced tree vigor, branch deformations, and shortened life span of the infected host (Conklin 2000). Reduced tree vigor and altered pitch flow associated with dwarf mistletoe infection would result in compromise of a tree's defense mechanisms to combat bark beetle attack, thus increasing the risk of successful bark beetle attack and mortality. Reduced tree growth and shortened life span would result in stagnation of VSS classes. Additionally, the accumulation of resin and branch deformations associated with dwarf mistletoe infection would result in increased fire hazard (Conklin, 2010, Hoffman et al. 2007).

Under the No Action Alternative, increasing stand densities would result in increased inter-tree competition and decreased tree vigor. Natural defense mechanisms against insect attack, such as the production of pitch, would be limited, resulting in increased susceptibility to successful bark beetle attack and mortality. As stand densities continue to increase over time, trees become stressed, thus increasing the probability of successful bark beetle attack within the project area and further increasing the risk of bark beetle attack to all surrounding trees (McMillin 2008).

Alternative 2, 3, & 4

Direct and Indirect Effects common to all action alternatives

Dwarf mistletoe is recognized as an endemic species and plays a natural role is the ecology of the forest. The following management recommendations set forth in the publication Dwarf Mistletoes and their Management in the Southwest (Conklin 2010) would be followed when treating stands infected with dwarf mistletoe. In lightly infected stands, where less than 25 percent of the area is infected, mistletoe would generally not be taken into consideration. Those lightly infected stands would be thinned similar to uninfected stands. In moderate to heavy infected stands or groups careful consideration would be made on how to treat stands and would follow the recommendations of the afore mentioned publication. It is expected that dwarf mistletoe infection levels would be reduced slightly from current infection levels and would be relatively stable after thinning and burning treatments are completed.

The table below (Table 53) displays the current and post-treatment dwarf mistletoe infection levels for stands that have stand exams. The general trend shows that infections levels drop after vegetation treatments and then gradually start going back up again overtime. For the most part, the infection levels are similar or slightly increased 40 years after treatment. This analysis is based on summing up the percentage of stands with stand exam data across the entire cover type. The numbers below represent percentage of stands, not percentage of area. It would appear that in the DLH, 29 percent of the ponderosa pine is severely infected; however a disproportionate number of stands with high levels of mistletoe infection were inventoried for stand exams while some stands that have very little to no mistletoe were not inventoried. The actual number of acres in pine with severe infection is much less. The point of the table below is to show how the proposed management affects infection levels over time.

The data generally shows that treatment in most areas of the project would result in a decrease in infection levels, sometimes for several decades. The greatest effect of the treatments, however, would be to allow for low and moderate intensity fire to occur in the project area. Studies have shown that prescribed burning can be a viable tool to manage mistletoe effectively (Conklin and Geils 2008). The models below all factor in prescribed burning in 2015.

Table 53: Current conditions and post treatment Dwarf Mistletoe Infection Level of ponderosa pine and mixed conifer as a percentage of stands with stand exams within FWPP

		Current Conditions		Post Treatment 2013		Post Treatment 2033		Post Treatment 2053	
Cover Type	Infection Level	Dry Lake Hills	Mormon Mountain	Dry Lake Hills	Mormon Mountain	Dry Lake Hills	Mormon Mountain	Dry Lake Hills	Mormon Mountain
Pine	None/Low	37%	69%	57	88	27	63	21	58
Pine	Moderate/ High	34%	31%	26	12	52	27	46	42
Pine	Severe	29%	0%	16	0	22	0	32	0
Mixed Conifer	None/Low	80%	91%	87	91	80	82	44	82
Mixed Conifer	Moderate/ High	20%	9%	14	0	19	18	51	9
Mixed Conifer	Severe	0%	0%	0	9	2	0	5	9

Current stand densities within the project area provide excellent habitat for increases in bark beetle and other insect populations. Insects are attracted to trees under stress from competition and a lack of resources, such as water, nutrients, and sunlight. The action alternatives would have an indirect effect on susceptibility to insect attack and mortality. Decreasing stand densities would reduce competition between trees, resulting in increased tree vigor and resilience. Individual trees would be better able to defend themselves against bark beetle attack (McMillin 2008, Negron 2009). After implementation of the treatments, the risk of insect attack and mortality for residual trees would be greatly reduced across the project area (Wallin et al. 2008).

Table 54 below shows the current and post treatment Bark Beetle hazard ratings for both DLH and MM. The treatments have a beneficial effect on the hazard ratings. Current conditions show the majority of stands have a high bark beetle hazard rating. After treatment, the majority of stands have a low hazard rating. Even after 40 years, bark beetle hazard ratings would remain significantly reduced.

Table 54: Current and Post Treatment Ponderosa Pine and Mixed Conifer Beetle Hazard Ratings (Percent of stands in each Project Area)

		2013 –Current Conditions		2013 - Post treatment		2033 – Post Treatment		2053 – Post Treatment	
Cover Type	Hazard Rating	Dry Lake Hills	Mormon Mountain	Dry Lake Hills	Mormon Mountain	Dry Lake Hills	Mormon Mountain	Dry Lake Hills	Mormon Mountain
Pine	Low	11%	3%	92%	13%	81%	75%	76%	41%
Pine	Moderate	13%	0%	5%	38%	14%	22%	22%	40%
Pine	High	76%	97%	3%	50%	5%	3%	3%	22%
Mixed Conifer	Low	0%	27%	69%	55%	51%	36%	32%	36%
Mixed Conifer	Moderate	5%	0%	17%	0%	32%	27%	41%	9%
Mixed Conifer	High	95%	73%	14%	45%	17%	36%	27%	55%

Cumulative Effects

The spatial boundary for this cumulative effects analysis includes the surrounding watersheds and landscape in the Flagstaff Ranger District; the forest conditions in these areas affect the forest conditions in the project area and are considered in conjunction with the FWPP project area for Forest Plan guidelines related to goshawk and old growth. Reasonably foreseeable activities to occur in the next 10 years are considered for cumulative effects in this analysis even though direct and indirect effects are modeled out to 40 years as after 10 years, the cumulative actions and their effects are too speculative to accurately analyze.

The DLH area lies in between and overlaps two other fuels reduction projects the Eastside fuels reduction project to the south, and the Jack Smith / Schultz fuels reduction project to the north. The Fort Valley Fuels Reduction project lies to the west. The DLH area is largest area adjacent to the community of Flagstaff that has not received fuels reduction treatment. This proposed action would complete a wide swath of fuels reduction treatment that was started around Flagstaff approximately 20 years ago.

The Mormon Mountain treatment area lies on the north slopes of Mormon Mountain and drains into Lake Mary. While there are no projects immediately adjacent to the project boundary, there are two nearby active projects. The Mormon Lake basin project to the south is a fuels reduction and forest health project to help protect Mormon Lake Village. To the north is the Elk Park Fuels Reduction and Forest Restoration project which is also located in the Lake Mary watershed. The 4FRI analysis area includes lands adjacent to the MM area, and is included in the table below. Table 56 list the various vegetation management, fuels treatment and other activities that have recently occurred, ongoing, or are likely to happen soon.

Table 55: FWPP Cumulative Effects Project List of past, present, and reasonably foreseeable actions in the Dry Lake Hills project area and surrounding areas.

	PAST	PRESENT (ONGOING)	REASONABLY-FORESEEABLE
Forest Thinning & Burning Projects	Fort Valley Experimental Forest (thinning & burning)		
		Wing Mountain Fuels Reduction Project. 4FRI task orders will be issued to treat the Wing Mountain Project beginning in 2015.	
	Eastside Fuels Reduction Project: approx. 16 acres of thinning around Elden communication towers done around 2008; 85 acres hand thinning along Elden Lookout Rd (past and ongoing); part of the Weatherford Task order outside FWPP project area (along with Jack Smith Schultz). Hand thinning occurring within the FWPP project boundary currently and on-going.		
	Jack Smith Schultz Fuels Reduction Project (and ongoing) Orion task order (867 acres)for 4FRI to be issued in 2014. Weatherford 4FRI task order (1017 acres) issued in 2013 Hand thinning occurring within the FWPP project boundary currently and on-going.		
	Elden Small Project (thinning and burning on 200 acres) 2002		
			4FRI – Would treat areas in the Fort Valley area and adjacent urban interface areas. The preferred alternative includes a total of 434,001 acres of mechanical thinning and 593,211 acres of prescribed burning to be implemented over the next 20 years.
			Treatments on the Navajo Nation parcel (approx. 140 acres) as well as adjacent State and private land
Wildfires	Schultz Fire (2010) 15,075 acres. BAER work included mulching, seeding and salvage, and hazard tree mitigation		
	Radio Fire (1977) 4,594 acres		
Restoration Work			4FRI Spring Enhancements
	Reforestation of 1000 acres of the	Reforestation of severely burned areas.	

	PAST	PRESENT (ONGOING)	REASONABLY-FORESEEABLE
	Schultz fire. Includes planting and jackstrawing.		
	Schultz Sediment Reduction – channel restoration work performed between FR 420 and the forest boundary on the National Forest by Coconino County to reduce erosion into the neighborhoods.		
Recreation	Arizona Trail construction		
		Special Use Events	
		Fort Valley Motorized Trails	
		Multi-use throughout DLH (hiking, mountain biking, camping) and trail maintenance	
			Expanded Mt. Elden and Dry Lake Hills Trail System
		Hunter Access to Aspen Depredation	
Grazing	Peaks Allotment (pastures not grazed in over 10 years; deferred from grazing now)		
Lands Projects			Elden/Devils Head comm sites – potential tower additions
	Travel Management Rule		

Table 56: FWPP Cumulative Effects Project List for past, present, and reasonably foreseeable actions in the Mormon Mountain project area and surrounding area.

	PAST	PRESENT (ONGOING)	REASONABLY-FORESEEABLE
Forest Thinning & Burning Projects	Mormon Lake Basin Fuels Reduction Project. MLB #1 Stewardship Contract (1597 acres)Completed in 2013	MLB #2 Stewardship Contract thinning in progress (568 acres).	
			4FRI – Would treat much of the area around Mormon Mountain and the Lake Mary

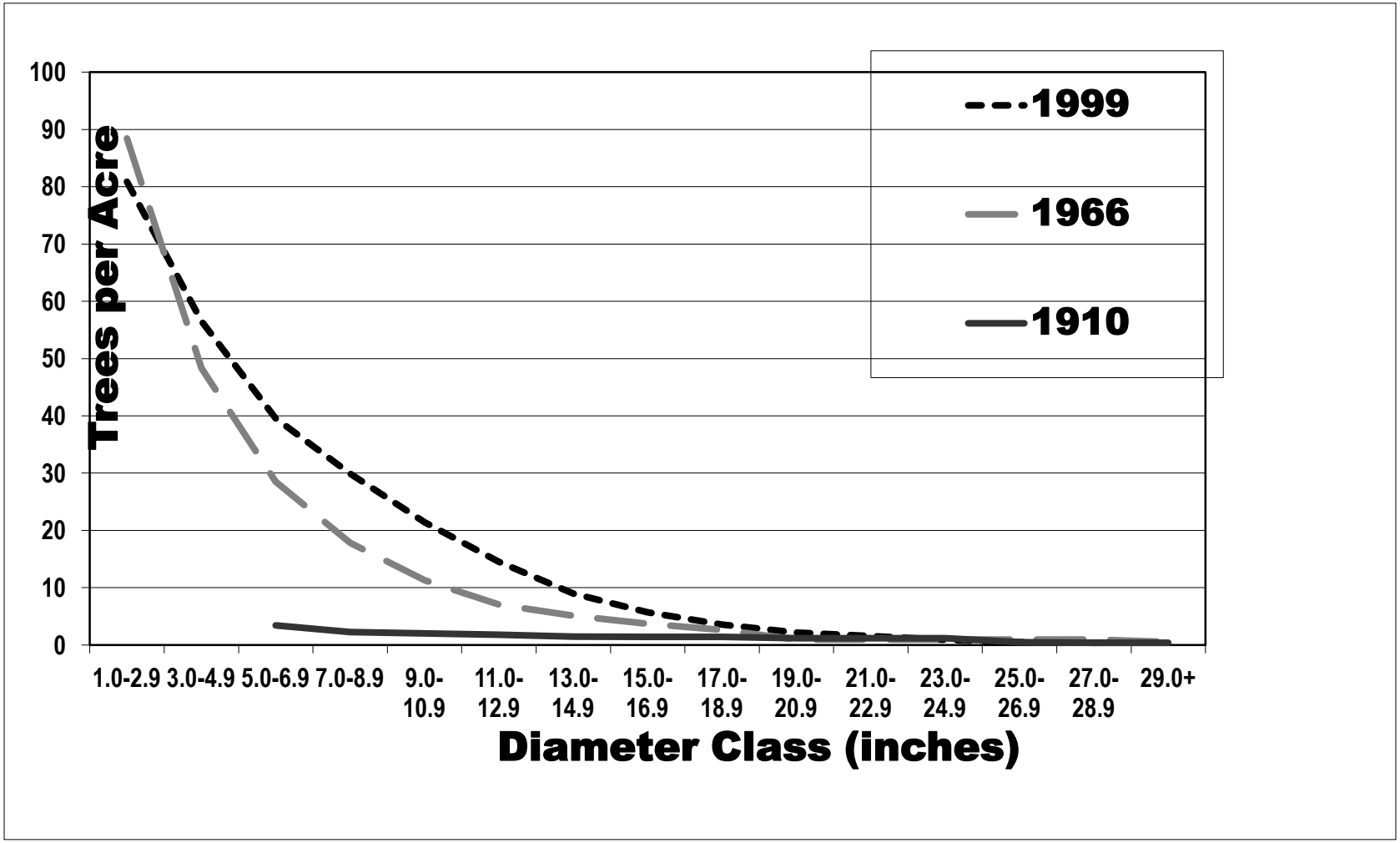
	PAST	PRESENT (ONGOING)	REASONABLY-FORESEEABLE
			Watershed with mechanical vegetation treatment and prescribed burning.
		Elk Park Project: Elk Park and Clark 4FRI task orders issued in 2013 will treat approximately 4,600 acres in the Lake Mary Watershed	
	Thinning around communication towers (11 acres) 2007-2008		
Wildfires	??		
Restoration Work			4FRI Spring Enhancements
Recreation		Dispersed recreation	
		Hunting	
		Fuelwood gathering	
Grazing	Tinny Springs Allotment: Five hundred cow/calf pairs are permitted to graze on the Tinny Springs allotment from June 1 through October 31 using a deferred rotation grazing system.		
	Pickett Lake/Padre Canyon Allotment: Nine hundred 13 adult cattle are permitted to graze on the allotment from June 1 through September 30 using a deferred, rest rotation grazing system.		
Lands Projects	Mormon Mt APS Line – final rehab needed but mostly complete		
			APS Young's to Mormon Lake new 69kv line
	Mormon Mt Comm Site		
		FH3 Tree Clearing	
	Travel Management Rule		

Cumulative Effects – Past Actions

Over the past century, several events, including fire exclusion, livestock grazing, and high-grade timber harvesting, occurred in ponderosa pine over the majority of the project area and in adjacent stands. These events resulted in disruption of the historic fire regime that consisted of frequent, low-intensity surface fires. In 1919, climatic events favored dense ponderosa pine

regeneration. At this time, understory production was greatly decreased by grazing and offered little competition with pine regeneration. As fire suppression and sawlog harvesting continued through the 20th century, regeneration from 1919 continued to grow in density. In the mid- to late 1900s, treatments in and adjacent to the project area removed a large proportion of the mature and old trees, contributing to a more even-aged forest structure. At the same time pre-commercial thinning treatments occurred that reduced the density of younger forest, mainly through even spacing of residual trees. Although these treatments did provide some short-term improvement to forest health, vigor, and growth by reducing stand densities and increasing the growing space of individual trees, they also caused further departure from the variable, patchy tree distribution that typified the historic ponderosa pine forest structure. Additionally, blending treatments were used to produce a single age class deemed "more manageable" in terms of regulated timber harvesting. Past events have resulted in increased stand densities, decreased age and size class diversity, altered stand structure, changes in successional dynamics, altered insect and disease dynamics, decreased understory productivity and diversity, decreased tree vigor, increased fuel accumulation and continuity, increased crown fire potential, increased fire size and intensity, and a more even-aged forest structure (Long 2003). Figure 8 depicts changes in trees per acre by size class on non-reserved forest lands in New Mexico and Arizona. The graph depicts changes that are typical of southwest ponderosa pine. The density of trees has increased significantly over time, especially in diameter classes less than 13 inches. With this tremendous increase in smaller size classes, size class diversity has decreased, resulting in a more even-aged forest structure.

Figure 8. Changes in stand density in southwestern ponderosa pine, non-reserved forest lands, NM and AZ (USDA Forest Service 2004).



Cumulative Effects – Alternative 1: No Action:
The cumulative effects of no action are show in tables 2 – 7.
The tables show a trend of reduced spatial heterogeneity, mortality of larger trees (especially aspen) and loss of high-elevation grasslands that would perpetuate. Canopy cover would remain high and or increase, thus further reducing understory biodiversity and production. Inter and intra species competition for limited space, water, and sunlight would continue and increase. Aspen would continue to decline from competition and shade induced mortality. Increasing density would make existing pine trees more susceptible to bark beetle attacks with mortality occurring at a higher rate. Mixed conifer stands would continue to retain high density and the more shade tolerant species which are less fire resilient will continue to encroach upon and shade out the fire adapted and less shade tolerant ponderosa pine within those stands. Existing high fire hazards would continue and increase the risk of an unnatural stand replacing fire to occur. Conifer encroachment would continue in the meadows and grasslands. Increasing density and canopy cover would also decrease understory species diversity of grass, forbs, and shrubs.

Climate change would continue to interact with the effects of fire suppression and increased tree densities to cumulatively increase the likelihood and severity of wildfires (Westerling et al. 2006). Those areas not affected by wildfire are likely to be more susceptible to bark beetle infestation resulting from the cumulative impact of a century of fire suppression and changing climatic conditions. Large tree recruitment would become more limiting over time as climate change imposes chronic drought and more widespread tree mortality (Diggins et al. 2010, Seager et al. 2010, Van Mantgem et al. 2009, Williams et al. 2012)

Cumulative Effects – Alternatives 2, 3, and 4
Alternative 2 would contribute an additional 8,937 acres toward improving forest health or fuels reduction and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Alternative 3 would contribute an additional 8,937 acres toward improving forest health or fuels reduction and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Alternative 4 would contribute an additional 5,802 acres toward improving forest health or fuels reduction and vegetation diversity/composition, sustaining old forest structure over time, and moving forest structure toward the desired conditions.

Cumulative Effects – Present and Foreseeable Management Activities.
Currently, there are two ongoing projects located adjacent and or inside the project area. The purpose of the Eastside and Jack Smith Schultz projects is to reduce hazardous fuel accumulation, while improving forest health and promoting the development of VSS distributions recommended by management recommendations for the Northern goshawk. One other project adjacent to the DLH project area has recently been completed. The Fort Valley project was a large scale restoration treatments to reduce hazardous fuel accumulation, while improving forest health. One other project that currently being undertaken is the Four Forest Restoration Project (4-FRI). 4-FRI is a very large landscape project that would treat the majority of the operable ponderosa pine forest across the entire district over the course of approximately 20 years. The treatments

proposed for the 4-FRI project will likely be somewhat similar but more open compared to the proposed FWPP treatments and aforementioned projects.

The recently-signed decision on the Coconino Travel Management Rule (September 2011) closes a number of roads within the DLH and MM project areas. We can expect the restricted travel will reduce the amount of snags and down wood removed for fuelwood harvest (Wisdom, 2008). This would partially counteract the effects of the proposed action that include a reduction in downed woody material over the next decade as the thinning and prescribed fire treatments would be implemented.

With the advent of global climate change, more frequent and higher intensity wildfires are expected (Marlon et al. 2009). Future droughts and temperature increase would also likely result in greater tree mortality from more frequent and higher intensity outbreaks of bark beetles (Van Mantgem et al. 2009, Williams et al. 2012). This project would make the forest more resilient and thus counteract the effects of climate change.

The proposed treatments in this EIS, in combination with ongoing projects adjacent to the project area, would result in a landscape which is more open, variable, and groupy for a minimum of 20 years into the future. The creation of openings and a more open canopy would result in increased natural regeneration across the landscape and a more uneven-aged forest structure, which would move conditions toward the desired condition of a well distributed age class with large, resilient trees in an uneven-aged structure across the landscape. A mosaic of varying forest structures, patterns, densities, and size classes results in increased horizontal and vertical heterogeneity, increased biological diversity, improved forest health, and a more sustainable forest structure at the landscape-level. A more sustainable forest structure is more resilient and capable of maintaining its health in the face of climate change and other disturbances such as insects, disease, and severe wildfires, which are expected to intensify under projected changes to the climate. The proposed alternatives and ongoing treatments would result in a decreased risk of insect attack and mortality at both the project and landscape levels.

Slash created from thinning activities would have the potential to increase brood habitat for *Ips* beetles and the potential for higher intensity ground fires from slash burning. The result of slash would be short-tern, until the site is treated with prescribed fire. Increased regeneration of ponderosa pine is expected to occur, but dog-hair thickets may be controlled through the planned maintenance burning (every 5 to 7 years in ponderosa pine).

These treatments would also result in faster development of a landscape-level VSS distribution recommended for the northern goshawk by retaining large trees, creating openings for regeneration, and increasing tree growth and vigor. Thus the cumulative effects of similar treatments within the landscape would be to move toward desired vegetation structure and age class diversity at the landscape scale over the next several decades. The treatments within the MSO PACs from projects such as Wing Mountain Fuels Reduction and Forest Health Restoration Project, 4FRI, Eastside Fuels Reduction Project and others would increase the resiliency of those stands to withstand wildfires and insect and disease attacks, which would support these areas in meeting desired conditions in the coming decades. The creation of small regeneration openings and restoration of historic grasslands and aspen stands across the landscape would also result in increased understory abundance, increased diversity at the landscape scale, and increases in insects, such as butterflies, that serve as prey bases for a suite of wildlife species. Increased grass and forb production would help spread and carry natural periodic surface fires. Lastly, by focusing on the removal of smaller diameter trees, this and other projects would retain and produce larger diameter trees for both ecological and social/aesthetic values.

Alternatives 2, 3 and 4 - Effects of Not Amending the Forest Plans

The following is a description of how the forest plan amendments under this EIS would modify the forest plan standards and guidelines and what the effects to the vegetation resource would be if the amendment did not occur.

- **Amendment 1**: A revised MSO Recovery Plan, issued by the U.S. Fish and Wildlife Service (FWS) was finalized in December of 2012 (USDI 2012). The current Forest Plan is consistent with the previous MSO Recovery Plan (USDI 1995). For this project, a Forest Plan amendment would be needed to utilize the revised recovery plan direction if it is different than what is currently included in the Forest Plan. The proposed Forest Plan amendment would modify Forest Plan language to allow mechanical treatments in MSO PACs up to 18 inches dbh and hand thinning treatments up to 5 inches dbh and prescribed burning within MSO nest/cores. The amendment would also allow removal of trees 24 inches dbh and greater in MSO protected or recovery habitat for cable logging corridors in order to facilitate treatments under Alternative 2. The monitoring requirement specified under the Forest Plan would be amended to include the monitoring plan developed by the Forest Service, U.S. Fish and Wildlife Service, and the Rocky Mountain Research Station referenced in the following section titled, "Monitoring." This amendment would also remove timing restrictions within MSO PACs for the duration of the FWPP project. Treatments within PACs would be accomplished as quickly as possible to reduce the duration of impacts, and would be coordinated with FWS. The purpose of this amendment would be to facilitate treatment in high-priority locations such as Mexican spotted owl occupied habitat to prevent high-severity wildfire. This is based on language in the Mexican Spotted Owl Recovery Plan (2012), which states, "[wildfires] result in the most significant alteration of owl habitat and hence, have the greatest potential for loss of habitat."

  If the amendment did not occur: 1) Mechanical treatments would be limited to a maximum of 9" dbh in the PACs thereby restricting the treatment to an ineffective fuels reduction objective and reducing the ability to improve MSO habitat in terms of reducing overall stand densities to desired levels, creating groups, openings, increasing or maintaining age class and species diversity, and liberation of overtopped oak.; 2) Without the use of prescribed fire in MSO core areas, the opportunity to improve MSO habitat in terms of reducing litter/duff cover and stimulating regeneration and growth of native herbaceous vegetation would be eliminated; 3) Treatments within MSO habitat would continue to meet the intent of the 1995 MSO recovery plan 4) Mechanical treatments within the nest roost recovery habitat would follow the denser 150 ft^2 basal area guidance thereby reducing the ability to improve MSO nesting/roosting habitat in terms of sustainability, as indicated by high potential for density related mortality and high bark beetle hazard rating as well as reducing the ability to improve age class and species diversity and the liberation of overtopped oak; 5) Implementation of vegetation treatments within the PACs would take 2 to 3 additional years.; 6) Following existing Forest Plan language concerning MSO population and habitat monitoring or MSO habitat design will not have an effect on the treatments themselves or their outcomes.

The result of the Forest Plan amendment is to facilitate mechanical thinning and prescribed fire in Mexican spotted owl habitat at a level necessary to meet the desired conditions and 2012 Mexican Spotted Owl Recovery Plan guidelines for forest structure and composition. This Forest Plan amendment will result in moving conditions toward a forest structure more in-line with the revised MSO recovery plan. The amendment would also have the effect of allowing thinning treatments which would enable managers to apply prescribed fire to the forest in a safe and effective manner. Furthermore the effect of this amendment would be to facilitate treatments to re-establish small openings that would result in greater understory biodiversity, improve the diversity of age classes, and reduced inter-tree competition and resilience to wildfire, drought, insects, and disease.

- **Amendment 2:** The current Forest Plan restricts the use of mechanical equipment to slopes less than 40 percent, but this restriction is not contained in the 2012 MSO Recovery Plan. Amendment 2 would remove the restrictive language related to 40 percent slopes and also the language identifying slopes above 40 percent as inoperable in order to allow mechanical harvesting on slopes greater than 40 percent within the project area.

  It would be necessary to allow for use of specialized mechanical equipment to cut and remove trees on steep slopes to reduce the risk of high-severity wildfire in this project area due to the preponderance of areas with greater than 40 percent slope in the project area. Furthermore, since the Forest Plan was written and amended, mechanized ground-based equipment has progressed to be able to operate on steep slopes more effectively. While this specialized equipment is not commonplace in this region due to the high cost of its use, the approval of the City bond makes the use of such equipment a possibility for this project. In order to be able to utilize such equipment to treat slopes above 40 percent in the project area and meet the purpose and need, this Forest Plan amendment is needed.

  If the amendment did not occur: It would not be technically feasible to treat areas on steep slopes to meet the desired conditions; Manual treatment (hand thinning and piling) would only be able to treat trees up to 9” in diameter due to safety concerns; Not treating to the desired condition would not allow for the safe use of prescribed fire on steep slopes in many areas of the project; In areas where prescribed fire could be done in terms of firefighter safety, the fire would not have the desired effect, and would cause high levels of mortality across the burned areas which would not achieve the desired fuels reduction and post fire flooding reductions.

  The result of the forest plan amendment is to allow for use of specialized mechanical equipment to cut and remove trees on steep slopes to reduce the risk of high-severity wildfire in this project area due to the preponderance of areas with greater than 40 percent slope in the project area. This amendment is needed. in order to be able to utilize such equipment to treat slopes above 40 percent in the project area in order to create the desired conditions and meet the purpose and need of this project.

Irretrievable and Irreversible Commitment of Resources

Each action alternative is designed to reduce the risk of high intensity wildfire and modify forest structure to perpetuate key forest elements such as large, old, trees and snags. Thus, there would be no irretrievable, irreversible effects to vegetation within the project area. The temporary loss of resources would only occur in places where roads would be constructed in forested areas to implement the proposed treatments. Production of timber would be temporarily lost within the road prism due to use of the road and the compaction that would occur. Temporary roads and log landings would be rehabilitated once treatments are complete. The loss of timber production would last during the time the temporary road are being used and for a few years after the road has been rehabilitated for the time that it takes for the compacted soil to naturally loosen up.

The effect of the temporary loss of timber productivity would have a minor impact in the short term and a minimal impact to the functionality of the forest over the long term. The impact is spread out over a large area and would not measurably decrease overall timber or understory production except for when the harvesting is occurring.

Design Features and Mitigation Measures

Log decks would not be left at the landings or in the treatment areas for such a period that would contribute to an increase in bark beetle populations. Logs and log decks would be removed from the project area in a timely manner.

Large old alligator junipers would be retained. Placement of roads, skid trails and landings would avoid cutting or damaging large alligator junipers.

Compliance with Forest Plan and Other Relevant Laws, Regulations, Policies and Plans

Multiple-Use Sustained Yield Act of 1960. Requires that national forest lands shall be administered for a variety of multiple uses, and that all resources shall be maintained as renewable in perpetuity for regular periodic output of several products and services at a sustainable level.

National Environmental Policy Act of 1969 (NEPA). Established procedures for decision making, disclosure of effects, and public involvement on all major federal actions.

National Forest Management Act of 1976 (NFMA). The Coconino forest plan was developed in accordance with NFMA, as expressed by the 1982 planning rule.

While federal laws like the National Forest Management Act establish the regulatory requirements of forest management for federal agencies, the detailed direction that affects the project-level vegetation analysis being undertaken in this proposed action are contained in the forest plans for the Coconino National Forest (USDA 1987, as updated 2008). These include the goals, objectives, direction, and Forest-wide and Management Area standards and guidelines that have relevance to the proposed action.

Coconino National Forest Plan Management Areas

The project area includes 11 Management Areas (MA) as described in the Coconino NF forest plan (pp. 46 to 206-113). The two main management areas comprising the project include: Ponderosa pine and mixed conifer on less than 40 percent slopes (MA-03) makes up

approximately 5,509 acres; and Ponderosa pine and mixed conifer on greater than 40 percent slopes (MA-04) makes up approximately 3,734 acres of the project area. The other management areas that are in the project area include: Aspen (MA-05) 91 acres; Unproductive Timber Land (MA-06) 672 acres; Pinon-Juniper Woodlands, greater than 40 percent slope (MA-08) 15 acres; Mountain Grasslands (MA-09) 46 acres; Grasslands and sparse Pinyon-Juniper Above the Rim (MA-10) 140 acres; Elden Environmental Study Area (MA-18) 268 acres; and Electronic Sites 28 acres. An additional 40 acres is classified as private lands which were formerly private but are now Forest Service land. In addition two additional management areas overlay the above listed management areas. In the Dry Lake Hills part of the project the Schultz management area (MA-36) overlays most of the project area. In the Mormon Mountain part of the project the Lake Mary Watershed Management Area (MA-35) also overlays most of this part of the project area.

Insect and Disease Management - Cuts are designed to eliminate or reduce dwarf mistletoe infections to manageable levels (CFP, page70).

Integrated Stand Management (ISM) - Establish and maintain stand diversity through ISM to provide suitable habitat for wildlife in lands suitable for timber production, while maintaining or enhancing timber resource production and timber age class distribution (CFP, page70).

Uneven-aged management will be emphasized (CFP, MA3, page 123).

Manage oak to improve wildlife habitat. Maintain oak components wherever they occur (CFP, MA3, page 131).

The alligator juniper component of the ponderosa pine is managed primarily for maintaining and enhancing wildlife habitat (CFP, MA3, page 132).

Reduce competition between closely spaced trees in some areas, to promote future large trees faster and to achieve desired tree sizes and canopy closures outlined in the Forest Plan (Mexican spotted owl and northern goshawk habitat guidelines) (CFP, FLEA, page 206-75).

Reduce competition between closely spaced trees in some areas to promote health and resistance to insects and disease (CFP, FLEA, page 206-75).

Table 12. Vegetation Management Practices for ponderosa pine, oak and aspen vegetation types as it applies to uneven-aged harvest systems , stand improvement thinning, intermediate thinning, and prescribed burning (CFP, page 242-19).

Region Wide Forest Plan Amendment

Forest vegetation management direction in the Coconino National Forest Land Management Plan (USDA 1987, as updated 2008) was amended in 1996 through a region-wide amendment of all forest plans in Arizona and New Mexico (USDA 1996).

Mexican Spotted Owl Recovery Plan

A revised Mexican spotted owl recovery plan was developed and signed by the US Fish and Wildlife Service in December of 2012. This project will be utilizing the management recommendations in the revised recovery plan.

Elements that relate to forest vegetation operations for the Mexican spotted owl include:

Provide habitat management for protected activity centers (PACs) and recovery habitat. Within PACs additional management consideration is given to the nest/roost core. Recovery habitat is

classified into nest/roost and foraging/non-breeding. Recovery habitat includes all mixed-conifer, pine-oak, and riparian outside of PACs.

The revised MSO recovery plan identifies stand-replacing wildfires as the primary threat to spotted owl habitat. Management recommendations are outlined in the recovery plan in appendix C (pp 249 – 298) to guide land managers with reducing the fire risk within the PACs and recovery habitat.

Protected activity centers (PACs)

All activities within the PAC should undergo consultation with the appropriate FWS office

No mechanical or prescribed fire during the breeding season

Removal of hardwoods, downed woody debris, snags, and other key habitat variables should occur only when compatible with owl habitat management objectives as documented through reasoned analysis

Light burning of surface and low-lying fuels may be allowed following careful review by biologist and fuel-management specialist. Generally, burns should be done during non-breeding season.

Mechanical treatments may be needed to reduce fire risk to owl/nest roost habitat. As a general guide, forest management programs in PACs should be structured as follows:

Conduct a landscape-level fire risk assessment to strategically locate and prioritize mechanical treatment units to mitigate the risk of large wildland fires while minimizing impact to PACs. Treatments should also strive to mimic natural mosaic patterns.

No mechanical or prescribed fire treatments should occur during the breeding season unless the PAC is unoccupied.

Recovery Habitats

Manage a minimum of 10% of the pine-oak and 25% of the mixed conifer for nest/roost habitat.

Manage recovery habitat for all stages of ecological succession. Maintain a mosaic of successional stages across the landscape.

Assess existing conditions at multiple spatial scales.

Treatments within recovery habitat nest/roost stands which meet the minimum desired conditions outlined on Table C.3 on page 278 of the MSO Revised Recovery Plan will not lower the conditions below those thresholds.

It is recommended that trees larger than 18 inches dbh not be removed in nest/roost recovery stands.

Maintain species diversity and allow for variation in stand structures including early seral species.

Strive to retain all trees greater than 24 inches dbh. Remove only to protect human safety and or property, or in situations where leaving large trees precludes reducing threats to owl habitat.

To the extent practical treatments should be designed to avoid the removal of trees over 18 inches dbh.

In pine-oak forests, retain existing large oaks and promote growth of additional oaks.

Elements that relate to northern goshawk forest habitat apply to the forest and woodland communities described below that are outside of Mexican spotted owl protected activity centers and recovery habitat areas:

Manage for uneven-age forest conditions for live trees and retain live reserve trees, snags, downed logs, and woody debris levels throughout woodland, ponderosa pine, mixed conifer, and spruce-fir forest cover types. Manage for old age trees such that as much old forest structure as possible is sustained over time across the landscape. Sustain a mosaic of vegetation densities (overstory and understory), age classes and species composition across the landscape.

Limit human activity in or near nest sites and Post-Fledgling Family Areas (PFAs) during the breeding season (March 1 through September 30).

The distribution of vegetation structural stages for ponderosa pine, mixed conifer and spruce-fir is 10% grass/forb/shrub (VSS 1), 10% seedling-sapling (VSS 2), 20% young forest (VSS 3), 20% mid-aged forest (VSS 4), 20% mature forest (VSS 5), 20% old forest (VSS 6). Distribution of habitat structures should be evaluated at the ecosystem management area level, at the midscale such as drainage, and at the small scale of site.

Landscapes Outside Goshawk PFAs:

Ponderosa pine: canopy cover for mid-aged forest (VSS 4) should average 40+%, mature forest (VSS 5) should average 40+%, and old forest (VSS 6) should average 40+%. Maximum opening size is up to 4 acres with a maximum width of up to 200 feet. Retain 1 group of reserve trees per acre of 3-5 trees per group for openings greater than 1 acre in size. Leave at least 2 snags per acre, 3 large downed logs per acre, and 5-7 tons of woody debris per acre. Snags are 18 inches or larger dbh and 30 feet or larger in height, downed logs are 12 inches in diameter and at least 8 feet long, woody debris is 3 inches or larger on the forest floor, canopy cover is measured with vertical crown projection on average across the landscape.

Identify and manage dispersal PFA and nest habitat at 2 to 2.5 mile spacing across the landscape.

Within PFAs:

Ponderosa pine: canopy cover for mid-aged forest (VSS 4) should average 1/3 60+% and 2/3 50+%. Mature (VSS 5) and old forest (VSS 6) should average 50+%.

Within Nesting Areas:

Thin from below with non-uniform spacing. Lopping and scattering of thinning debris is preferred if prescribed fire cannot be used. Piling of debris should be limited.

Elements that relate to forest vegetation operations for old growth allocation:

Seek to develop or retain old growth function on at least 20% of the naturally forested area by forest type in any landscape.

All analyses should be at multiple scales-one scale above and one scale below the ecosystem management areas.

Monitoring Recommendations

Areas proposed for harvest under selection cutting can be regenerated using standard reforestation techniques. The reforestation technique and range of desired stocking would be documented in a formal silvicultural prescription. These areas would be monitored by the implementation silviculturist to ensure the areas meet the prescribed post treatment stocking. If the areas do not meet desired stocking after 5 years, conditions that are inhibiting regeneration would be identified and remedial action may be prescribed to ensure regeneration.

References (Literature Cited)

Abella, Scott R. 2008. Managing Gambel oak in southwestern ponderosa pine forests: the status of our knowledge. Gen. Tech. Rep. RMRS-GTR-218. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 27 p.

Abella, S.R.; Denton, C.W. 2009. Spatial variation in reference conditions: Historical tree density and pattern on a *Pinus ponderosa* landscape. Canadian Journal of Forestry 39:2391-2403.

Abella, S.R.; Denton, C.W.; Brewer, D.G.; Robbie, W.A.; Steinke, R.W.; Covington, W.W. 2011. Using a terrestrial ecosystem survey to estimate the historical density of ponderosa pine trees. Research Note RMRS-RN-45. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO. 9 pp.

Allen, S.R.; Savage, M.; Falk, D.A.; Suckling, K.F.; Swetnam, T.W.; Shulke, T.; Stacey, P.B.; Morgan, P.; Hoffman, M.T.; Klingel, J.T. 2002. Ecological restoration of southwestern ponderosa pine ecosystems: A broad perspective. Ecological Applications 12(5):1418-1433.

Breece, C.R., Kolb, T.E., Dickson, B.G., McMillin, J.D., Clancy, K.M. 2007. Prescribed fire effects on bark beetle activity and tree mortality in southwestern ponderosa pine forest. Forest Ecology and Management. 255 (2008) 119-128.

Brown, P.M.; Kaye, M.W.; Huckaby, L.; Baisan, C. 2001. Fire history along environmental gradients in the Sacramento Mountains, New Mexico: Influences of local patterns and regional processes. Ecoscience 8:115-126.

Chojnacky, D.C., B.J. Bentz, and J.A. Logan. 2000. Mountain pine beetle attack in ponderosa pine: comparing methods for rating susceptibility. USDA Forest Service Research Paper, RMRS-RP-26, 10 pp.

Cocke, A.E., Fule P.Z., Crouse J.E. 2005. Forest change on a steep mountain gradient after extended fire exclusion: San Francisco Peaks, Arizona, USA. Journal of Applied Ecology, 42, 814-823.

Conklin, D.A., Fairweather, M.L. 2010. Dwarf Mistletoe Management and their Management in the Southwest. USDA Forest Service. Southwestern Region.

Conklin, D. A., & Geils, B. W. (2008). Survival and sanitation of dwarf mistletoe-infected ponderosa pine following prescribed underburning. Western journal of applied forestry, 23(4), 216-222

Cooper, C.F. 1960. Changes in vegetation, structure, and growth of southwestern pine forests since white settlement. Ecological Monographs 30:129-164.

Covington, W.W.; Moore, M.M. 1994a. Postsettlement changes in natural fire regimes and forest structure: Ecological restoration of old-growth ponderosa pine forests. Journal of Sustainable Forestry 2(1/2):153-181.

Covington W.W., Moore M.M. 1994b. Southwestern ponderosa pine structure: changes since Euro-American settlement. Journal of Forestry 92: 39-47.

Covington, W. W., Fule, P. Z., Moore, M. M., Hart, S. C., Kolb, T. E., Mast, J. N., Sackett, S. S., and M. R. Wagner. 1997. Restoring ecosystem health in ponderosa pine forests of the southwest. Journal of Forestry, 94 (4): 23-29.

Das, A., Battles, J., Stephenson, N. L., & van Mantgem, P. J. (2011). The contribution of competition to tree mortality in old-growth coniferous forests. Forest ecology and management, 261(7), 1203-1213.

DeMars, C.J., and B.H. Roettgering. 1982. Western pine beetle. USDA Forest Service Forest Insect & Disease Leaflet 1. 8 p.

Davis, Liane R.; Puettmann, Klaus J.; Tucker, Gabriel F. 2007. Overstory Response to Alternative Thinning Treatments in Young Douglas-fir Forests of Western Oregon. Northwest Science. 81(1): 1-14.

Diggins, C.; Fule P.Z.; Kaye, J.P.; Covington W.W. 2010. Future climate affects management strategies for maintaining forest restoration treatments. International Journal of Wildland Fire 19, 903-913.

Dixon, Gary E. comp. 2002. Essential FVS: A user's guide to the Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. 240p. (Revised: November 24, 2010)

Ehle, D.S.; Baker, W.L. 2003. Disturbance and stand dynamics in ponderosa pine forests in Rocky Mountain National Park, USA. Ecological Monographs 73:543-566

Fairweather, Mary Lou, Brian W. Geils, and Mike Manthei. "Aspen decline on the Coconino national forest." Proceedings of the 55th Western International Forest Disease Work Conference. Salem, OR, USA: Oregon Department of Forestry. 2008.

Fiedler, C.E.; Arno, S.F.; Harrington, M.G. 1996. Flexible silvicultural and prescribed burning approaches for improving health of ponderosa pine forests. Pp 69-74 in Covington, W.W.; Wagner, P.K. (eds.). Conference on adaptive ecosystem restoration and management: Restoration of Cordilleran conifer landscapes of North America. General Technical Report RM-GTR-278. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Friederici, P. 2004. Establishing reference condition for southwestern ponderosa pine forest. Working papers in southwestern ponderosa pine forest restoration. Ecological Restoration Institute. Flagstaff, AZ. 16 p.

Frinkral, A.J.; Evans, A.M. 2008. Effects of thinning treatment on carbon stocks in a northern Arizona ponderosa pine forest. Forest Ecology and Management 255:2743-2750.

Fulé, P.Z.; Covington, W.W.; Moore, M.M. 1997. Determining reference conditions for ecosystem management of southwestern ponderosa pine forests. Ecological Applications 7:895–908.

Fulé, P.Z.; Crouse, J.E.; Heinlein, T.A.; Moore, M.M.; Covington, W.W.; Vankamp, G. 2003. Mixed-severity fire regime in high-elevation forest of the Grand Canyon, Arizona, USA. Landscape Ecology 18:465-486.

Fule, P.Z., Covington, W.W., Stoddard, M.T., Bertolette, D., 2006 "Minimal-Impact" Restoration Treatments Have Limited Effects on Forest Structure and Fuels at Grand Canyon, USA. Restoration Ecology Vol. 14, No. 3, pp.357-368

Ganey J.L, and Vojta S.C. 2011. Tree mortality in in drought-stressed mixed-conifer and ponderosa pine forests, Arizona, USA. Forest Ecology and Management 261 (2011) 162–168

Gill, S.; Biging, G.S.; Murphy, E.C. 2000. Modeling conifer tree crown radius and estimating canopy cover. Forest Ecology and Management 126:405-416.

Grady, Kevin C. and Stephen C. Hart. 2006. Influences of thinning, prescribed burning, and wildfire on soil processes and properties in southwestern ponderosa pine forests: A retrospective study. Forest Ecology and Management Vol. 234. pp. 123-135.

Hayes, C. J., Fettig, C. J., & Merrill, L. D. (2009). Evaluation of multiple funnel traps and stand characteristics for estimating western pine beetle-caused tree mortality. Journal of economic entomology, 102(6), 2170-2182.

Heinlein, T. A., Moore M. M., Fule F. Z., and W. W. Covington, 2005. Fire history and stand structure of two ponderosa pine-mixed conifer sites: San Francisco Peaks, Arizona, USA. International Journal of Wildland Fire, 14: 307-320

Hoffman, C., Mathiasen, R., & Sieg, C. H. (2007). Dwarf mistletoe effects on fuel loadings in ponderosa pine forests in northern Arizona. Canadian journal of forest research, 37(3), 662-670.

Hurteau, M. and M. North. 2009. Fuel treatment effects on tree-based carbon storage under modeled wildfire scenarios. Frontiers in Ecology and the Environment, 7:409–414.

Hurteau, M. D., M. T. Stoddard, and P. Z. Fule. 2011. The carbon costs of mitigating high-severity wildfire in southwestern ponderosa pine. Global Change Biology, 17:1516–1521.

Kaye, M.W.; Swetnam, T.W. 1999. An assessment of fire, climate, and Apache history in the Sacramento Mountains, New Mexico, USA. Physical Geography 20:305-330.

Kenaley S.C., Mathiasen R.L., Daugherty C.M. 2006. Selection of dwarf mistletoe-infected ponderosa pines by Ips species (Coleoptera: Scolytidae) in northern Arizona. Western North American Naturalist 66(3): 279-284.

Kenaley S.C., R.L., Mathiasen, and E.J. Harner. 2008. Mortality Associated with a Bark Beetle Outbreak in dwarf mistletoe-infested ponderosa pine stands in Arizona. Western Journal of Applied Forestry 23: 113 - 120.

Keyser, Chad E.; Dixon, Gary E., comps. 2008 (revised February 3, 2010). Central Rockies (CR) Variant Overview – Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. 66p.

Kolb, T.E., Agee, J.K., Fule, P.Z., McDowell, N.G., Pearson, K., Sala, A., Waring, R.H. 2007. Perpetuating old ponderosa pine. Forest Ecology and Management, 249 (2007) 141-157.

Korb, J. E., Fule, P. Z., Stoddard M. T. 2012. Forest restoration in a surface fire-dependent ecosystem: an example from a mixed conifer forest, southwestern Colorado, USA. Unpublished.

Laughlin, D.C.; Moore, M.M.; Bakker, J.D.; Casey, C.A.; Springer, J.D.; Fulé, P.Z.; Covington, W.W. 2006. Assessing targets for the restoration of herbaceous vegetation in ponderosa pine forests. Restoration Ecology 14:548-560.

Lezberg, Ann L.; Battaglia, Michael A.; Sheppard, Wayne D.; Schoettle, Anna W. 2008. Decades-old silvicultural treatments influence surface wildfire severity and post-fire nitrogen availability in a ponderosa pine forest. Forest Ecology and Management, 255: 49-61 pps.

Long, J.N. and F.W. Smith. 1984. Relation between size and density in developing stands: a description and possible mechanism. For. Ecol. And Management 7:191-206.

Long, J.N., 1985 A Practical Approach to Density Management. Forestry Chronicle. February, pp 23-27

Long, J. 2003. Disturbance Ecology. Continuing Education in Ecosystem Management for the Central and Southern Rockies and Great Basin. October 27 – November 7, 2003. Utah State University, Logan, Utah.

Long, J. N. and F. W. Smith. 2000. Restructuring the Forest. Goshawks and the restoration of southwestern ponderosa pine. Journal of Forestry, 98 (8): 25-30.

Long, J.N. and T.W. Daniel. 1990. Assessment of growing stock in uneven-aged stands. Western Journal of Applied Forestry. 5:93-96.

Munson S, Anhold J. 1995. Site risk rating for mountain pine beetle in ponderosa pine. Unplished, RMRS, Intermountain Region, Ogden UT.

Manion, P.D. (1991). Tree Disease Concepts. 2nd ed. Prentice-Hall: New Jersey

Mast, J.N.; Fulé, P.Z.; Moore, M.M.; Covington, W.W.; Waltz, A.E.M. 1999. Restoration of presettlement age structure of an Arizona ponderosa pine forest. Ecological Applications 9:228-239.

Mast, J.N.; Veblen, T.T.; Linhart, Y.B. 1998. Disturbance and climatic influences on age structure of ponderosa pine at the pine/grassland ecotone, Colorado Front Range. Journal of Biogeography 25:743-767.

McCusker N., 2012. Four-Forest Restoration Initiative Coconino and Kaibab National Forests Silviculture Specialist Report. USDA Forest Service.

McMillin J.D., 2008. Stand hazard rating for bark beetles attacking southwestern ponderosa pine. USDA Forest Service, Rocky Mountain Research Station. Unpublished.

McMillin, Joel D. et al. 2011. Draft hazard rating for Ips beetles during drought in Arizona. Unpublished paper on file at: U.S. Department of Agriculture, Forest Service, Southwestern Region, State and Private Forestry, Forest Health Protection, Flagstaff, AZ. 1 p.

Menzel, J.P.; Covington, W.W. 1997. Changes from 1876 to 1994 in a forest ecosystem near Walnut Canyon, northern Arizona. Pp 151-172 in van Riper III, C.; Deshler, E.T. (eds.). Proceedings of the Third Biennial Conference of Research on the Colorado Plateau. Transactions and Proceedings Series NPS/NRNAU/NRTP-97/12. Dept. of the Interior, National Park Service. 256 pp.

Moir, W.H. 1966. Influence of ponderosa pine on herbaceous vegetation. Ecology 47:1045-1048.

Moir, W. H., Geils, B., Benoit, M. A., and D. Scurlock. 1997. Ecology of Southwestern Ponderosa Pine Forests. Pages 3-27 in Block, W. M. and D. M. Finch, tech. ed. Songbird ecology in southwestern ponderosa pine forests: a literature review. Gen. Tech. Rep.

RM-GTR-292. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 152 pp

Moore, M.M.; Huffman, D.W.; Fulé, P.Z.; Covington, W.W.; Crouse, J.E. 2004. Comparison of historical and contemporary forest structure and composition on permanent plots in southwestern ponderosa pine forests. Forest Science 50:62-176.

Naumburg, E.; DeWald, L.E. 1999. Relationships between Pinus ponderosa forest structure, light characteristics, and understory graminoid species presence and abundance. Forest Ecology and Management 124:205-215

Negrón, J.F., J.L Wilson, and J.A. Anhold. 2000. Stand conditions associated with roundheaded pine beetle (Coleoptera: Scolytidae) infestations in Arizona and Utah. Environmental Entomology 29: 20-27.

Negron, J.F., McMillin J.D., Anhold J.A., Coulson, D. 2009. Bark beetle-caused mortality in a drought-affected ponderosa pine landscape in Arizona, USA. Forest Ecology and Management. 257 (2009) 1353-1362.

North, Malcolm, ed. 2012. Managing Sierra Nevada forests. Gen. Tech. Rep. PSW-GTR-237. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. Chapter 2 pp. 13-23.

Pearson, G.A. 1950. Management of ponderosa pine in the Southwest: As developed by research and experimental practice. Agriculture Monograph No. 6. USDA Forest Service, Fort Collins, CO. 34 pp.

Reineke, L. H. 1933. Perfecting a stand density index for even-aged forests. Journal of Agricultural Research 46(7):627-638.

Reynolds, R. T., Graham, R. T., Reiser, M. H., Bassett, R. L., Kennedy, P. L., Boyce, D. A., Goodwin, G., Smith, R., and E. L. Fisher. 1992. Management recommendations for the northern goshawk in the southwestern United States. Gen. Tech. Rep. RM-217. Ft. Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 90 pp.

Ritchie, Martin W.; Wing, Brian M.; Hamilton, Todd A. 2008. Stability of the Large Tree Component in Treated and Untreated Late-Seral Interior Ponderosa Pine Stands. Can. J. For. Res. 38: 919-923 pps.

Sánchez Meador, A.J.; Parysow, P.F.; Moore, M.M. 2010. Historical stem-mapped permanent plots increase precision of reconstructed reference data in ponderosa pine forests of northern Arizona. Restoration Ecology 18:224-234.

Schmid, J.M., and S.A. Mata. 1992. Stand density and mountain pine beetle-caused mortality in ponderosa pine stands. USDA Forest Service Research Note, RM-515.

Schmid, J.M., S.A. Mata, R.A. Obedzinski. 1994. Stand hazard rating ponderosa pine stands for mountain pine beetles in the Black Hills. USDA Forest Service Research Note, RM-529.

Schubert, Gilbert H. 1974. Silviculture of southwestern ponderosa pine: The status of our knowledge. Res. Paper RM-123. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 71 p.

Seager, R.; Vecchi, G.A.2010. Greenhouse warming and the 21st century hydroclimate of wouthwestern North America. PNAS, vol. 107, no. 50, 21277-21282

Shepperd, W. D., Asherin, L. A., and Edminister, C. B. 2002. Using individual tree selection silviculture to restore northern goshawk habitat: Lessons from a southwestern study. Beyond 2001: A Silvicultural Odyssey to Sustaining Terrestrial and Aquatic Ecosystems. Proceedings from the 2001 National Silviculture Workshop, May 6 – 10, 2002, Hood River, Oregon. PNW-GTR-546.

Smith, Ed. 2006. Historical Range of Variation and State and Transition Modeling of Historical and Current Landscape Conditions for Spruce-Fir of the Southwestern U.S. Prepared for the U.S.D.A. Forest Service, Southwestern Region by The Nature Conservancy, Tucson, AZ. 37 pp.

Society of American Foresters. 1998. The dictionary of forestry. Bethesda, MD: 210 pp.

Society of American Foresters (SAF). 2005. Use of silviculture to achieve and maintain forest health on public lands. Position Statement Available at: http://www.safnet.org/policyandpress/psst/silviculture.pdf

Swetnam, T.W.; Baisan, C.H. 1996. Historical fire regime patterns in the southwestern United States since AD 1700. Pp 11-32 in Allen, C.D. (ed.). 2nd La Mesa Fire Symposium; Los Alamos, NM. General Technical Report RM-GTR-286. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 216 pp.

USDA Forest Service. 1950's. Coconino National Forest Land Historic Timber Atlas. Southwestern Region. (This is an unpublished document).

USDA Forest Service. 1996. Coconino National Forest Land and Resource Management Plan. Southwestern Region.

USDA Forest Service, 1992. Rocky Mountain Resource Information System Oracle User Guide. Southwestern Region.

USDA Forest Service. 1997. Plant associations of Arizona and New Mexico. 3rd ed. Vol. 1. USDA Forest Service, Southwestern Region, Albuquerque, NM. 291 pp.

USDA Forest Service, 2004. Forest Restoration and Fuels Reduction Thinning in the Southwest. Presented at the Regional Silviculture Workshop, Southwestern Region, June 17, 2004.

USDA Forest Service. 2008. Forest insect and disease conditions in the Southwestern Region, 2007. USDA Forest Service, Southwestern Region, Forestry and Forest Health, PR-R3-16-4, 47 p. Albuquerque, New Mexico.

USDA Forest Service. 2011. Forest insect and disease conditions in the Southwestern Region, 2010. USDA Forest Service, Southwestern Region, Forestry and Forest Health, PR-R3-16-7, 45 p. Albuquerque, New Mexico.

USDI Fish and Wildlife Service 2012

Vandendriesche, Don, comp. 2010. A compendium of NFS regional vegetation classification algorithms. Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. 74p.

van Mantgem, P.J.; Stephenson, N.L.; Byrne, J.C.; Daniels, L.D.; Franklin, J.F.; Fule, P.Z.; Harmon, M.E.; Larson, A.J.; Smith, J.M.; Taylor, A.H.; Veblen T.T. 2009. Science, vol. 323 pp 521-524

Wallin, K. F., Kolb, T. E., Skov, K. R., & Wagner, M. (2008). Forest management treatments, tree resistance, and bark beetle resource utilization in ponderosa pine forests of northern Arizona. Forest ecology and management, 255(8), 3263-3269.

Weaver, H. 1951. Fire as an ecological factor in southwestern ponderosa pine forests. Journal of Forestry 49:93-98.

Westerling, A. L.; Hidlago, H.G.; Cayan, D.R.; Swetnam, T.W. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. Science. Vol. 313: 940-943.

White, A.S. 1985. Presettlement regeneration patterns in a Southwestern ponderosa pine stand. Ecology 66:589-594.

Williams et al. 2012. Temperature as a potent driver of regional forest drought stress and tree mortality. Nature Climate Change. 30 September 2012. NCLIMATE1693

Wisdom, M.J., and Bate, L.J. 2008. Snag density varies with intensity of timber harvest and human access. For. Ecol. Manage. 255: 2085–2093.

Woolsey T.S. Jr. 1911. Western yellow pine in Arizona and New Mexico. USDA Forest Service, Bulletin 101. Washington, DC.

Zegler, T. J., Moore, M. M., Fairweather, M. L., Ireland, K. B., & Fulé, P. Z. (2012). Populus tremuloides mortality near the southwestern edge of its range. Forest Ecology and Management, 282, 196-207.

Appendix A.

Flagstaff Watershed Protection Project
Old Growth Allocations by 10k Blocks

10k #213
The majority of this 10K is located within FWPP. Portions of this 10K are in the Eastside and Jack Smith /Schultz Projects. There are currently 3523 acres designated in this 10K. Of those acres, 2633 occur within the FWPP project. Utilizing more current information the acreage of existing/designated acreage would change to 2306 acres designated with in the FWPP project area. The revised total for existing and designated old growth would be: 3196 acres. The percent of forested areas within the project area designated as existing or developing old growth would be 24%.

Total acres in 10k = 14351
Forested ac in 10k (MA 3, 4, 5, 6, 7, 8, 13, 18) = 13500
20% of forested ac (old growth required for the whole 10k) = 2700
Current existing or designated old growth in 10K = 3523
Change in Acres for Existing or Designated as old growth in project area = 2633 ac
Revised total existing and designated for 10K = 3196 ac

10k #314
Approximately 59 acres of this 10K occurs within the FWPP. All 59 acres are currently designated as developing old growth. There are currently 2264 acres of designated existing or developing old growth in this 10K which is approximately 33% of the forested acres within the 10K. All acreages would stay the same.

Total acres in 10k = 9062
Forested ac in 10k (MA 3, 5, 6, 17, and the Experimental Forest) = 6836
20% of forested ac (old growth required for the whole 10k) = 1367
Current existing or designated old growth in 10K = 2264
Change in Acres for Existing or Designated as old growth in project area = None
Total existing and designated for 10K = 2264 ac

10k #507
Only 455 aces of the FWPP project occurs within this 10K.
There are currently 143 acres designated in this 10K. All of those acres, all occur within the FWPP project. The 4FRI project would designate an additional 7349 acres of stands towards the old growth allocation. According to 4FRI some stands are managed for less than 100% coverage of old growth. However their analysis provides for 20% old growth across their project area.

Utilizing 4FRI's proposed old growth allocation and FWPP proposed developing old growth, designated acreage of old growth would change to 7386 acres designated with in this 10K. The percent of forested areas within the project area designated as existing or developing old growth would be 73%.

Total acres in 10k = 10553
Forested ac in 10k (MA 3, 4, 5, 6, 7) = 10051
20% of forested ac (old growth required for the whole 10k) = 2010
Current existing or designated old growth in 10K = 143

Change in Acres for Existing or Designated as old growth in project area = 7243 ac
Revised total existing and designated for 10K = 7386 ac

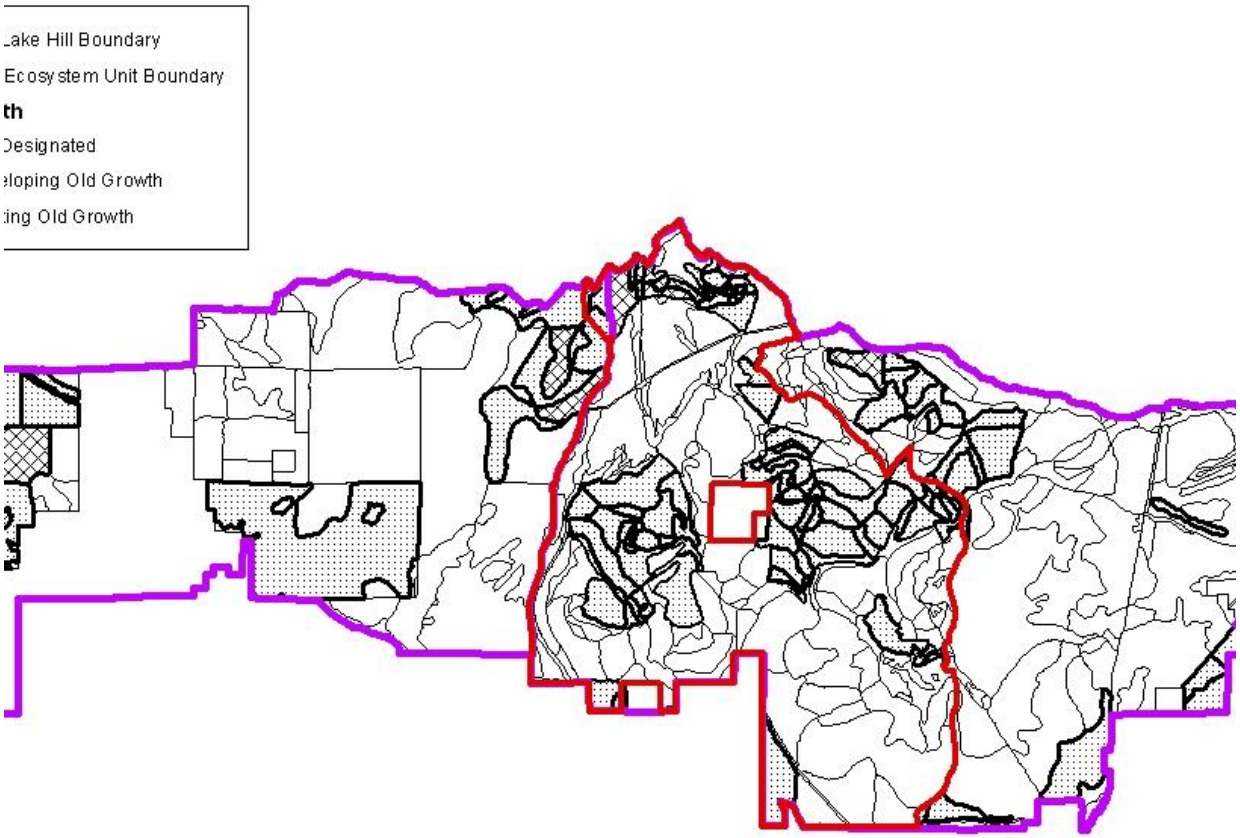
10k #514
Only 1889 aces of the FWPP project occurs within this 10K.
There are currently 600 acres designated in this 10K. All Of those acres, approximately 450 occur within the FWPP project. The 4FRI project would designate an additional 5199 acres of stands towards the old growth allocation. Then within the FWPP portion of the 10K an additional 693 acres would be allocated toward developing or existing old growth. This is a total of 6492 acres allocated in this 10K According to 4FRI some stands are managed for less than 100% coverage of old growth. However their analysis provides for 20% old growth across their project area The percent of forested areas within the project area designated as existing or developing old growth would be 70%.

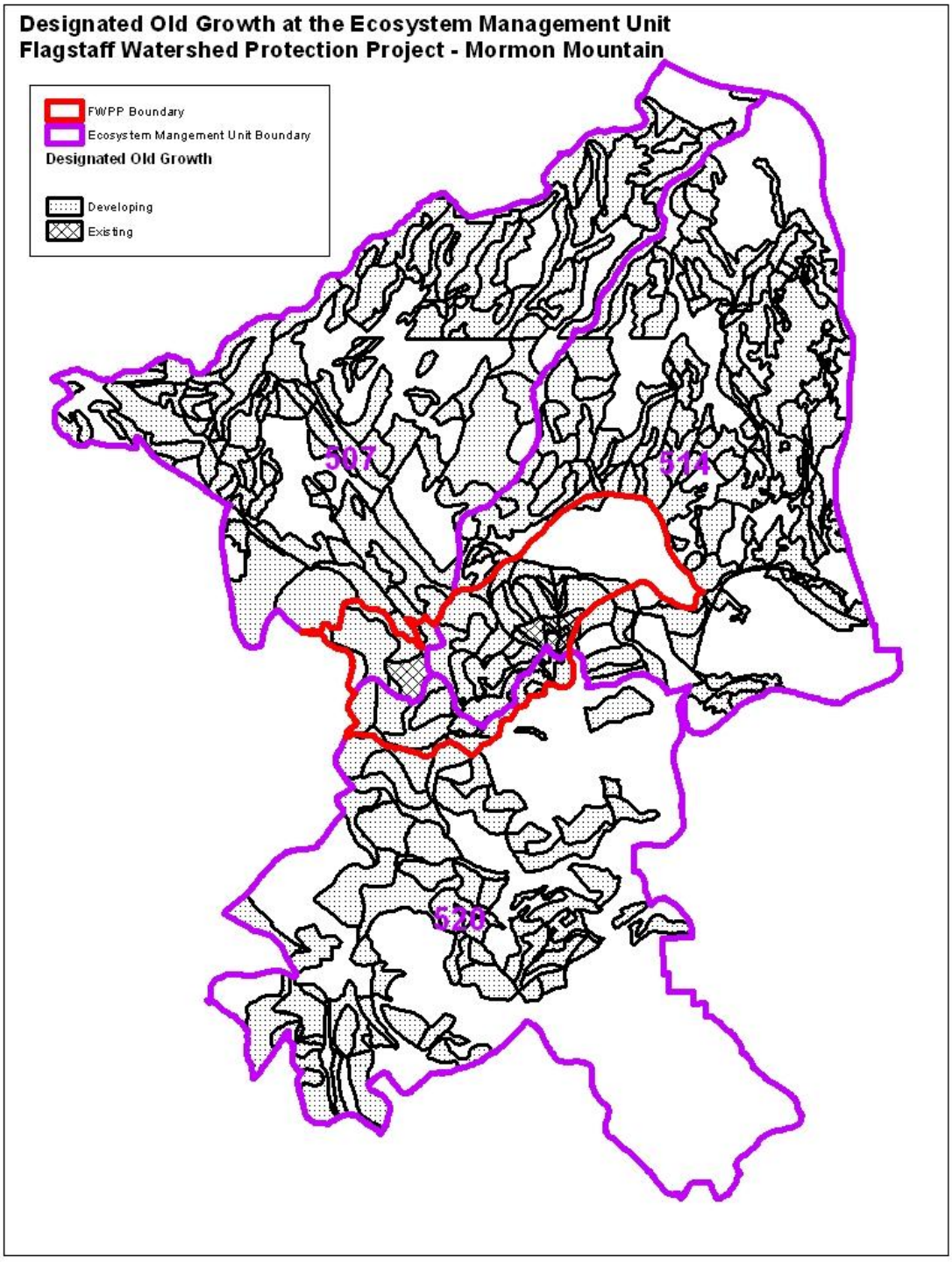
Total acres in 10k = 11643
Forested ac in 10k (MA 3, 4, 5, 6, 7) = 9300
20% of forested ac (old growth required for the whole 10k) = 1860
Current existing or designated old growth in 10K = 600
Change in Acres for Existing or Designated as old growth in project area = 5893 ac
Revised total existing and designated for 10K = 6492 ac

10k #520
Only 631 aces of the FWPP project occurs within this 10K.
The 4FRI project would designate an additional 4151 acres. The FWPP project would allocate an additional 619 acres. This would designate a total of 4770* acres (FWPP+4FRI).
The percent of forested areas within the project area designated as existing or developing old growth would be 42%.

Total acres in 10k = 11638
Forested ac in 10k (MA 3, 4, 5, 6, 7) = 11322
20% of forested ac (old growth required for the whole 10k) = 2264
Current existing or designated old growth in 10K = 0*
Change in Acres for Existing or Designated as old growth in project area = 4770 ac
Revised total existing and designated for 10K = 4770 ac

Hills Old Growth 10K Analysis
Watershed Protection Project




Designated Old Growth at the Ecosystem Management Unit
Flagstaff Watershed Protection Project - Mormon Mountain
FWPP Boundary
Ecosystem Mangement Unit Boundary
Designated Old Growth
Developing
Existing
507
514
520

Appendix B.

Historic photos of the Dry Lake Hills showing forest conditions at the time of photos.